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GLASS-METAL SEALS

By PETER J. GAYLOR

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Prior to the present war, there was some demand for hermetically sealed instruments but the art was not sufficiently developed to give a reasonably inexpensive product of this type. However, as soon as our war operations began to extend into the southwest Pacific, considerable instrument damage was immediately encountered from humidity and fungus sources so that no time was lost in instituting further extensive research and development on hermetic glass-metal sealing.

The problem of hermetic sealing with glass-metal joints has been attacked in three different ways: (1) Modifying the metal composition to obtain the same expansion coefficient as that of glass, (2) Modifying the glass composition to obtain the same expansion coefficient as that of the metal (generally iron), and (3) Developing a new sealing technique to enable ordinary glass and iron or steel to give a suitable seal.

There are several limiting factors in the design of a hermetically sealed closure. It must add as little as possible to the physical size. Also, the end cap should not be larger in diameter than the glass enclosure, so that the unit may be strapped to a metal chassis without shorting. Above all, there must be no possible leakage to allow breathing with temperature variations.

Metal Modification

Some pure metals are available, such as platinum, which have nearly the same coefficient as that of glass, but they are generally too expensive for use in mass-produced articles. Early electric lamp bulbs employed platinum, but this was later replaced by manganin (83 per cent Cu, 13 per cent Mn and 4 per cent Ni) or Eldred's wire which was a core of nickel steel, a jacket of copper, and an outer sheath of platinum[1].

In recent years, use has been made of the alloy Kovar, the expansion coefficient of which is almost identical with that of glass. This alloy contains 29 per cent Ni, 17 per cent Co and 54 per cent Fe and, in the annealed form, it has a tensile strength of 70,000 psi[2]. It is claimed[3] that this alloy forms a chemical bond through the heating process in which the oxides of the metals in Kovar become dissolved into the glass, thus giving a permanent vacuum and pressure-tight seal. Such seals are suitable for operation at —55 deg. C. to 200 deg. C. and are tested for thermal shock before leaving the factory. The electrode is usually insulated by a glass blob holding a novel eyelet. The seals are sold separately and can be soldered to an instrument to provide a hermetic construction.

In the Kovar-sealed units, the metal is sealed to the inside of the glass, thus making the end small enough to avoid shorting. All other parts are soldered in place so that there is a definite seal with no chance of leakage. Figure 1 shows a Hanovia R. F. Choke sealed in this manner.

The steps employed in producing Marion Instrument Co. units are outlined as follows in a booklet issued by the company. A) A one-piece drawn steel cup forms the outer case of the instrument. Fastened to this cup are two standard Kovar glass bead terminals which are soldered by the use of high frequency induction heating. After the terminals are soldered, the entire case is given a phosphate finish which will withstand a 200 hour salt spray test. The specialty shaped rib and recess provide a seat for the glass cover. B) In the second operation, the moving system is installed in the steel cup. The moving system, another simplified design, comprises a heavy duty solid Alnico magnet, with accurately positioned sintered soft iron pole shoes and a single unit moving coil assembly set in a hardened beryllium copper frame. All pointers are of aluminum tubing. Balance weights are of hardened beryllium copper, crimped for a secure lock on the balance cross so that the instrument will not become unbalanced under severe shock service. C) Next in order of assembly is the scale plate. This plate is made of brass, coated with a metal primer and three coats of finish which give it a satin eggshell surface. The standard AWS scale, or multi-color scale

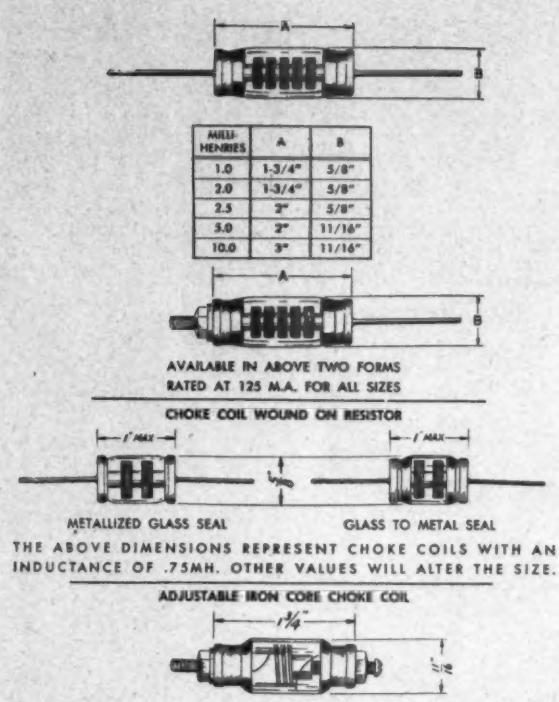

Fig. 1.

for special applications, is then individually printed and registered on the dial. Because of the unique construction of the instrument, the scale plate provides a much longer scale length and better visibility than is conventional for any instrument of equal size. D) The "key" to the Marion glass-to-metal hermetic sealing process is the double thickness tempered glass window, with a metallized band, developed and produced by the Corning Glass Works. This glass window, convex in shape, is high frequency induction soldered to the steel cup, in a matter of seconds, after the instrument has been completely dehydrated in our dehydrating room. The bond between the metallized glass rim of the steel case, made with 63-67 solder is capable of withstanding extreme thermal shock. E) Lastly comes the mounting of the black satin finished anodized aluminum cover plate and flange. This is mounted over the glass-to-metal seal by the three screws which are used to attach the instrument to its panel. The function of the flange is purely decorative and does not, in any way, affect the sealing of the instrument. It, too, is treated to withstand severe salt spray tests without deterioration. Figure 2 illustrates the assembly. It is contended that these instruments cost no more than standard unsealed instruments. Air entering the instrument room is filtered by a Westinghouse Precipitron and dehydrated with calcium chloride baffles, thus insuring an absolutely clean instrument. The instrument is seated on a jig with a one-turn loop beneath its rim, and is heated by a 30 mc R.F. current passing through the loop. When flow temperature is reached in a matter of seconds, the operator applies a ring of solder and finishes the job. The glass bead terminals are attached in a similar manner.

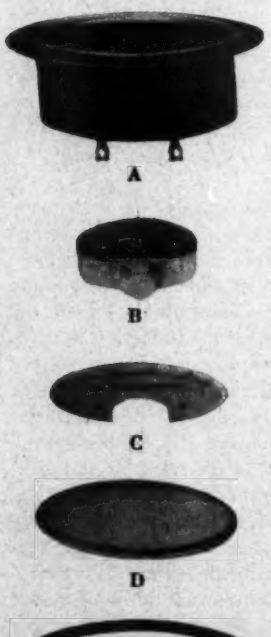

Fig. 2.

Chilcot[4] has reported that small tungsten seals in a hard borosilicate glass, which are completely vacuum-tight under normal conditions, become permeable to water when immersed in wet steam or in hot or cold water. Apparently liquid water must be present and the effect is not one of diffusion, since the seals are not permeable to hydrogen.

A method of making glass-metal seals described in a Sprague Electric Co. patent[5] and illustrated in Figure 3 employs a borosilicate glass tube 10 over the end of which is a sleeve of lead 14 integrally bonded to the glass. The metal cap 12 is then soldered on to the lead around edge 15.

Glass Modification

Some time ago, General Electric Co. obtained a U. S. patent[6] on a ceramic material adapted to be sealed to glass. It was a heat reaction product of a mixture of at least 50 per cent steatite and magnesia, zirconia or zirconium silicate. Because of the unavailability of platinum, nickel or cobalt during the war, G.E. developed a series of glass compositions[7] which can be used with iron and certain iron alloys. One such composition consists of 45 per cent SiO_2, 14 per cent K_2O, 6 per cent Na_2O, 30 per cent PbO and 5 per cent CaF_2 and has an expansion coefficient very close to that of iron. Incidentally, it has been found that when a glass containing lead is sealed in contact with iron some of the lead migrates from the glass into the metal, thus weakening the joint and encouraging air leakage. Therefore, a thin layer of lead-free glass is first coated on the metal to avoid this.

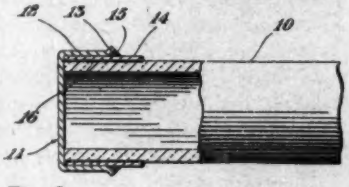

Fig. 3.

General Electric is making glass terminal seals for small capacitors[8], the seal capable of being brazed to the capacitor cover, giving a fungus, humidity and shock-resistant assembly. As can be seen from Figure 4, the terminal is riveted to the top metal section, such construction resulting in high mechanical strength. G.E.'s new 2½ in. hermetically sealed panel instruments are prepared by first sealing a thick, special, strain-free glass window to a metal ring. This ring is then soft soldered to the case thereby giving a moisture and fungus proof indicating instrument. The final assembly is evacuated and filled with inert gas before sealing off at a pressure slightly above atmospheric. They are capable of withstanding a thermal shock test

of at least 10 alternate exposures in salt water at 85° C. and then at 0° C. without moisture penetration or damage to the finish[9]. It is claimed that the sealing technique on their fixed paper-dielectric capacitors does not rely on matched coefficients of expansion of metal and glass to resist thermal shock, nor on soft solder for mechanical strength.

In Figure 5, a typical patented[10] insulator device is shown for a welded attachment in an opening in a metal wall. The insulator body 4 contains a well 5 containing bonded metal to which is welded a metal diaphragm 6. A hermetic seal is made in the container by welding or soldering the edge of the flange to the metal wall 2. The glass has a thermal expansion coefficient matched to that of the flange.

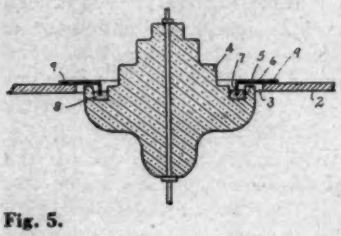

Fig. 5.

Other Sealing Techniques

One method of fusing steel and glass in a permanent airtight seal for metal electron tubes has been disclosed by Dr. G. R. Shaw of R.C.A. Instead of using special alloys, ordinary steel is employed, and a good deal depends upon the control of processing so as to secure good wetting of the steel by the glass. The new procedure also incorporates a mechanical design which provides compression strains at the glass-metal boundary and thus compensates for the difference in expansion of the two materials.

In this technique, the outer edges of a flat round glass button are sealed to the inside of a metal band known as the header insert, the glass button serving to insulate the wire leads connecting the internal elements of the tube with the pins on the base by means of which it is plugged in. As can be seen from Figure 6, the header insert is used to join the button to the header, a ring of steel which, with the button, forms the floor of the tube and is welded to the open end of the envelope to support the internal structure and complete the enclosure.

Fig. 6, Airtight steel-to-glass seal for metal tubes. The header insert is the ring-like band of metal encircling the glass button through which the wire leads are introduced into the tube. Before the new procedure was developed, it was necessary to make the insert from special alloys which are more costly and sometimes scarce.

The principle involved[11] depends on the fact that glass is a solvent for oxides, so that by applying intense heat from fine jets of gas flame to the outside of the oxidized steel band, after the glass has been softened and pressed into a button inside the band, it is possible to cause any excess oxides to dissolve into the glass. Too much oxidation prevents adhesion to the glass, while too little leaves a porous interface between metal and the glass. It has been pointed out that kitchen enamelware is produced by a similar technique by adherence of an easily oxidized metal (iron) to a low softening-point glass.

A header insert of chrome iron (containing 25 per cent Cr) was first employed until the war caused a shortage of this important metal. With the present technique, steel has been found suitable, provided the proper temperature and other factors are employed.

Among the methods disclosed for sealing vitreous

(*Continued on page* 528)

Fig. 4.

BATCH HOUSE ASSIGNABLE CAUSES IN DENSITY CONTROL

The main purpose of the density control chart, technique[1] is to insure the production of glass of controlled chemical composition. As long as the plotted points stay within the density limits, the chemical composition is assumed to be under control. When the plotted points fall outside the density limits, the glass is assumed to be out of control and such points indicate assignable causes (Fig. 1). To eliminate these assignable causes a search must be made of the process and whatever is giving rise to these causes must be corrected if the composition is to be brought back under control. Ghering has found that many of the assignable causes which he has investigated have their origin in the batch or in the batch house. A review of the relationship between the batch house and assignable causes, therefore, seems to be worthwhile as it will not only serve as a guide for those who are attempting to track down such causes but will also emphasize that this is one phase of glass manufacturing that cannot be neglected if the process is to stay under control.

In the case of the raw materials being used, it is not necessary that their composition be that of the ideal material as small departures from the theoretical can be successfully compensated for by the plant glass technologist. It is very important, however, to have the supply of raw materials uniform from shipment to shipment. If large variations in chemical composition of the raw materials occur in the shipments, it is usually not possible to make the necessary corrections in the proper manner. For example, if the raw material storage bins are such that they contain several carloads of material at one time, composition variations in different shipments of a material will cause the development of strata of varying composition material in the bin. As these different compositions of material are used in the batch assignable causes will develop.

With manufactured raw materials such as soda ash and borax, uniformity of chemical composition is fairly easy to obtain. In the case of naturally occurring raw materials such uniformity is difficult to attain, especially in those cases where different deposits are supplying the material in question. In many cases, however, the raw material supplier has the necessary equipment to blend his product and hence is able to insure and supply a material that is constant in chemical composition. In those cases where this cannot be accomplished and the glass manufacturer must depend upon several different deposits of material, the only remedy for the situation is the use of separate bins for the product of each deposit. Chemical control and supervision is thereby necessary if variable composition materials are used, as such materials are excellent assignable causes.

Constancy of raw material composition also includes factors such as the moisture content of the raw materials, the drying out of damp raw materials and the pickup of moisture and carbon dioxide by certain materials either through accident or normal storage. While the raw material supplier may be shipping material that has proven to be constant in composition, leaky freight cars may be used which, if shipped during a rainy period, will allow the material to pick up excessive amounts of moisture. If such a material is used without correction for its moisture content, the difference in weight may often be great enough to cause serious differences in the composition of the batch and, of course, the resulting glass. Likewise, if wet sand is used in the batch, large variations in the weight of sand actually in the batch will result, if no attempt is made to keep the moisture content of the sand constant. In the case of raw materials that pick up moisture and carbon dioxide during storage, it is good practice to run the storage bin empty at regular periods. If this is not done, there will always be some material that will remain in the storage bin for long periods of time, gradually increasing in volatile content and which will sooner or later become used in the batch. Constant checking of the moisture content or the ignition loss of such materials when received, while in storage, and before use is necessary if this source of assignable causes is to be eliminated.

Somewhat related to constancy of raw material composition is the accidental mixing of different raw materials while in storage. If the storage bins are properly constructed and if raw material conveying lines do not run through the bins, intermixing of the materials through leakage or spillage seldom occurs. If open wooden storage bins are used, this type of contamination may take place and constant checking of the condition of the bins is necessary if it is to be eliminated or controlled. The absolute prevention is, of course, the construction of a fool proof, leak proof storage system. In the new types of storage bins, intermixing of the raw materials is usually due to the human element. If the unloading of the cars is not properly supervised, indifference or carelessness on the part of the man unloading the car will often result in the material being unloaded into the wrong bin. Such a mistake is usually not noticed until the glass goes bad and is an assignable cause of the first magnitude. Fool proof unloading system, proper supervision and training of those responsible for this part of the operation can do much towards its elimination.

The weighing and the mixing of the batch are two items that cannot be overlooked when assignable causes are being tracked down. In many cases of large density variations the final analysis of all of the factors involved usually points the finger to either one or the other of these two items. In the case of the weighing of the batch raw materials, many semi-automatic systems are so constructed that no provision is made for the batch mixer operator to correct an overweight condition. In most manual systems, the correction of an over-weight condition is left to the integrity of the batch mixer operator. In either case the result is that the overweight is not corrected and excess material is used in the batch.

In manual systems the best method of correcting such

[1]Refined Method of Control of Cordiness and Workability of Glass During Production, L. G. Ghering, *Jour. Amer. Ceramic Soc.*, Vol. 17, No. 12, 1944.

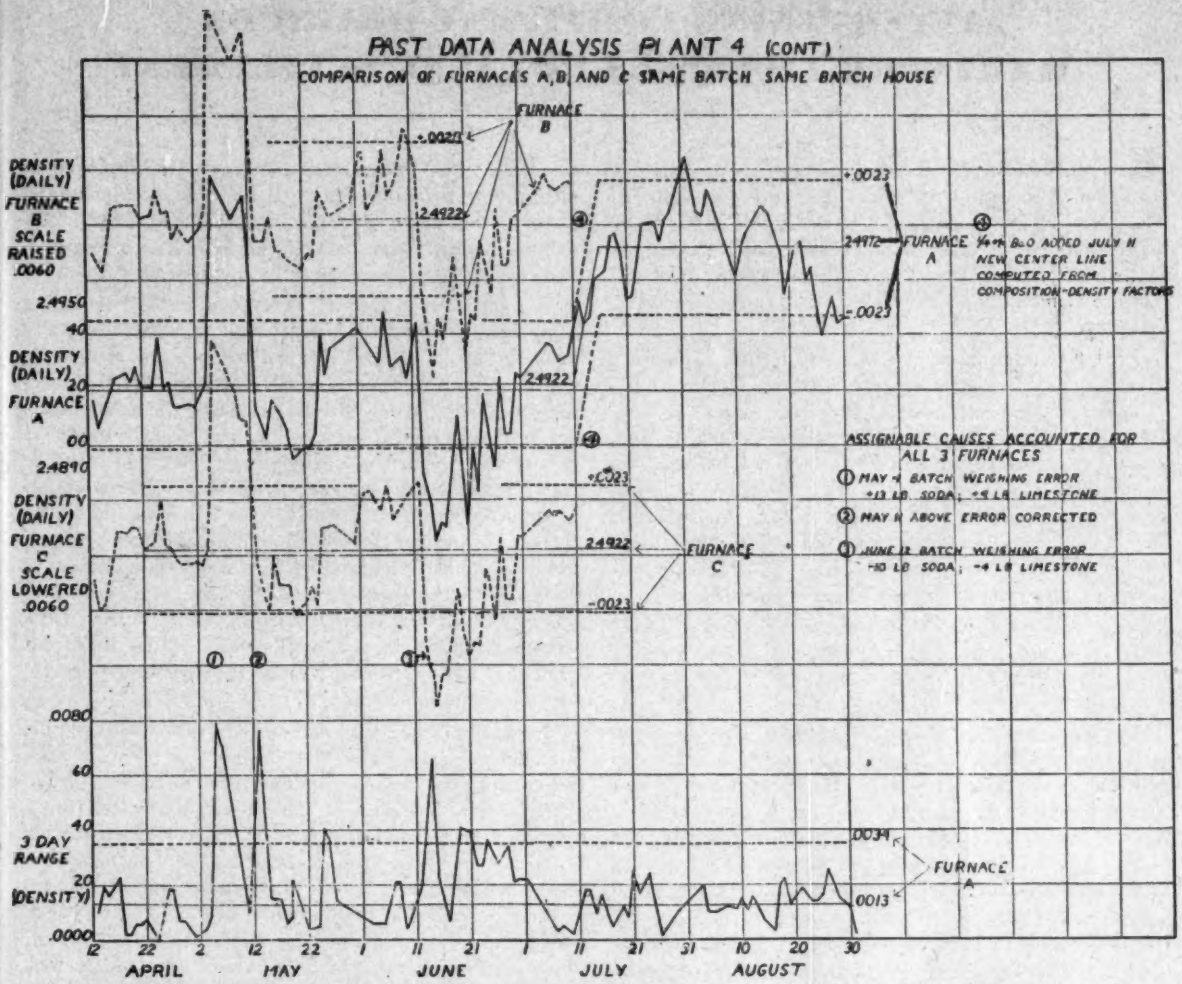
PAST DATA ANALYSIS PLANT 4 (CONT)
COMPARISON OF FURNACES A, B AND C SAME BATCH SAME BATCH HOUSE
DENSITY (DAILY) FURNACE B SCALE RAISED .0060
DENSITY (DAILY) FURNACE A
DENSITY (DAILY) FURNACE C SCALE LOWERED .0060
3 DAY RANGE (DENSITY)
FURNACE B
FURNACE A
FURNACE C
+.0022
24922
24972
-.0023
+.0023
-.0023
.0034
.0013
.0080
.0000
ASSIGNABLE CAUSES ACCOUNTED FOR ALL 3 FURNACES
① MAY 4 BATCH WEIGHING ERROR +13 LB. SODA; -9 LB. LIMESTONE
② MAY 11 ABOVE ERROR CORRECTED
③ JUNE 12 BATCH WEIGHING ERROR -10 LB SODA; +4 LB LIMESTONE
④ 1/4 lb B.O ADDED JULY 11 NEW CENTER LINE COMPUTED FROM COMPOSITION-DENSITY FACTORS
12 22 2 12 22 1 11 21 1 11 21 31 10 20 30
APRIL MAY JUNE JULY AUGUST

Fig. 1. A density control chart for two furnaces (after L. G. Ghering). Three assignable "batch house" causes are shown.

a condition is the careful training of the batch mixer operator in the importance of his job. In the semi-automatic system, a means of correcting over-weight should be provided and recording scales installed as a check on the actual amount of material being weighed. Recording scales will show not over over-weights and under-weights, but will also indicate errors due to the omission of materials. If each scale is equipped with a suitable recording device, a tabulation of each weight and the number of weights at the end of each mixing shift will give an excellent check on the performance of the batch mixer operator. Such printed records will eliminate many of the headaches that accompany a search for assignable causes, as a glance at the record quickly shows if off-composition batches have been fed into the doghouse. Without a record of the actual amounts of material that were weighted out, it is almost impossible (in a post mortem investigation) to be sure that the weighings were faulty, as a cross examination of the operator usually yields little worthwhile data.

In many cases, the human element is not at fault and improperly weighed materials or batches are the result of mechanical troubles in the batch scales. When the batch scales are connected with or are a part of the mixer, the continual jarring and vibration present when the mixer is running will often cause the scale to be thrown out of balance. Systematic checking of the scales with standard weights or the re-weighing of a known amount of material on a secondary or a standard scale is necessary in such cases, if accuracy of the batch weighings is to be assured. Where recording devices are used, it is necessary to systematically inspect and check such devices if reliance is to be placed on the printer records. A procedure that can be easily followed where recording type scales are used is to weigh standards both at the beginning and the end of the mixing period or if mixing is done continuously, the standards may be weighed at fixed intervals. All weighings are then subjected to a continuous check and assignable causes due to variations caused by off-balance scales can be eliminated.

Turning to the mixing of the batch, it is well known that an intimate mix cannot be obtained and that segregation is apt to occur if the various materials used in the batch vary too greatly in their grain size. With the exception of cullet, this difference in the grain sizes of the various materials does not give as much trouble now as it did several years ago. The various raw materials manufacturers now supply material in which the grain

(*Continued on page* 531)

INTERVENING COMPLAINT HEARD ON HARTFORD LICENSEES ROYALTY SETTLEMENT

Early in October, Federal Judge Frank L. Kloeb entered an order in the anti-trust suit of the government against Hartford-Empire Company, Owens-Illinois Glass Company and eleven other companies looking toward the settlement of all outstanding disputes between Hartford-Empire Company and the glass container manufacturing industry.

Fred E. Fuller of Welles, Kelsey, Fuller, Cobourn & Harrington, acting as attorney for Anchor Hocking Glass Corporation, Lancaster, Ohio, Brockway Glass Co., Inc., Brockway, Pennsylvania, Buck Glass Company, Inc., Baltimore, Maryland, Foster-Forbes Glass Company, Marion, Indiana, Gayner Glass Works, Salem, New Jersey, and Knox Glass Bottle Company, Knox, Pennsylvania, filed an intervening complaint in the case for these companies on behalf of themselves and all other manufacturers of glass containers not already parties to the litigation. The filing was consented to by all parties to the case, including the United States, and Judge Kloeb's order to show cause on the proposed settlement was scheduled to be heard on October 22nd.

As this issue of THE GLASS INDUSTRY goes to press, it is reported that the hearing was held as scheduled and that Judge Kloeb has ruled favorably on the intervening complaint except in the matter of "use royalties". Article 2 of the intervening complaint deals with the manufacture of machinery by manufacturers other than Hartford and is headed "License to Make, Have Made and Use" and provides for the payment of royalties by Hartford licensees to Hartford when such equipment is used. It is in this particular that Judge Kloeb reserved decision and indicated that an attempt would be made to enter a final judgment on November 1.

In the intervening complaint Anchor Hocking Glass Corporation, and others, set forth the appointment of James A. Shanley, of Hartford, Connecticut, as receiver of Hartford-Empire Company by order of Judge Kloeb on October 8, 1942, the collection of over $20,000,000.00 in royalties by him from licensees of the Hartford-Empire Company since that date, and the final judgment of the Supreme Court of the United States that the many Hartford licensees must continue as licensees giving up their claims to the royalties paid the receiver or repudiate their licenses and litigate their rights to any part of the funds collected by the receiver.

Shortly after the Supreme Court decision in January, 1945, according to the intervening complaint, a number of Hartford licensees, including those intervening in the Toledo case, appointed a committee consisting of I. J. Collins, chairman of the board of Anchor Hocking Glass Corporation, Robert L. Warren, president of Brockway Glass Company, Inc., Royden A. Blunt, vice-president of Buck Glass Company, Inc., Francis H. May, vice-president of Foster-Forbes Glass Company, Lewis F. Gayner, executive vice-president of Gayner Glass Works, and R. R. Underwood, president of Knox Glass Bottle Company, to work out a program covering the future relationship between Hartford-Empire and its licensees. Mr. Fuller and his firm were employed as counsel for the committee, and he states, the complaint filed is the result of agreement reached after many months of negotiation between the committee, representatives of Hartford-Empire and the government.

The proposed agreement, as set forth in the intervening complaint, provides for the payment to Hartford-Empire licensees of more than $13,000,000.00, the release by Hartford-Empire licensees of all claims against Hartford-Empire arising from past transactions, the continuance of Hartford-Empire licenses on substantially reduced royalty rates, which it is alleged will result in a yearly saving to licensees of about $4,750,000.00, the adoption of uniform license agreements for all glass container manufacturers, and the provision of an adequate research and development program by Hartford-Empire Company. Forms of the proposed new license agreements and royalty rate schedules, which according to Mr. Fuller, have been worked out in cooperation with Hartford-Empire Company and representatives of the Attorney General, are attached to the complaint.

Mr. Fuller states that substantially all Hartford-Empire licensees approved the proposed settlement subject to approval by Judge Kloeb. Judge Kloeb's order provided for the filing of any objections by Hartford-Empire licensees and stockholders prior to the date set for hearing and set October 22nd as the date for hearing on objections. It was anticipated that the form of final judgment in the anti-trust case here involving a number of glass container manufacturers, the trial of which consumed many months time, and which was heard and reheard by the Supreme Court, would be for hearing before Judge Kloeb on the same day.

UHRMANN TO VISIT EUROPE ON GOVERNMENT MISSION

At the designation of the Chemicals Unit, Operations Division of the Foreign Economic Administration in Washington, C. J. Uhrmann has been made a member of the Technical Industrial Intelligence Committee to visit Great Britain and Western Europe as a technical observer and scientific consultant for the Joint Intelligence Objectives Agency under the Joint Chiefs of Staff.

Mr. Uhrmann, Vice President and Plant Manager of Imperial Glass Company, will leave the United States in the very near future and travel with other members on this Committee. He will visit all existing glass manufacturing operations in the scheduled countries in the interests of securing glass manufacturing and techniques information of value to the United States. Mr. Uhrmann is on leave of absence from his company to embark on this mission and his corporate duties will be assumed by other officers of Imperial and his departmental assistants.

REFRACTORIES OF THE FUTURE

By RAYMOND E. BIRCH
Director of Research, Harbison-Walker Refractories Co.

An investigator for an important New York investment firm which appropriates large sums of money for market studies recently closed an interview with a refractories manufacturer by casually remarking that, "What we are trying to learn is whether or not yours is a dying industry." Actually we don't look at it that way, and we fail to see many of the signs of decadence. Neither, we think, do the users of refractories. These producers of the materials of war and peace, having come through our Nation's greatest trial with the aid of refractories amply produced in high quality and delivered when needed, can be excused for regarding the refractories industry as a fairly lively corpse.

Still the idea is not exactly new and it has been expressed in a number of different ways. The latest angle is the one voiced by *Fortune* magazine in saying that the makers of refractories comprise "The industry back of industry," and that this basic industry "has done such a good job in research that its volume is shrinking."[1]

To understand this question one must first note a significant feature which differentiates the refractories industry from kindred industries manufacturing, for example, building brick. The latter product is used in structures which in general must only resist the ravages of weather and of those who tear down buildings to make parking lots. Refractory brick, by contrast, are consumed by heat, by molten slags and by other agencies which may in many cases require their replacement in a matter of a few weeks or months. Their renewal requires time for cooling the furnace, for the mason's work and for again heating the furnace. During this delay, the normal output, having a value many times the cost of the refractories, is irreplaceably lost. This situation provides the impetus for research. When refractories are devised and so utilized as to minimize furnace delays, money is saved, even though these better refractories may be more expensive.

An outstanding example of what may be accomplished by superb furnace design and maintenance, and by continuous evolution of refractories practice has been written up by W. B. Boggs, Smelter Supt. of Noranda Mines Ltd., and his associates.[2] A furnace initially planned for the smelting of 500 tons of copper ore daily was by late 1938 smelting 1500 tons of charge per day "by the use of the suspended magnesite roof" in place of the prior refractories. But this was only a beginning. In the five-year period since 1938, further changes have made it possible to increase the tonnage of ore smelted daily in a single furnace to the amzaing total of 2500 tons.

But doesn't this add up to decreased business in terms of total units of refractories needed for furnace maintenance? Indeed it does. In time it will bring about a scrapping of obsolescent plants and a certain shifting of operations geographically as well as in other ways. However, within the industry these adjustments are viewed optimistically. Refractories are a basic commodity essential to all industry. So long as man utilizes high temperature processes, he will need to confine the heat and this will require refractories. Furthermore, temperatures almost never are lowered as processes are changed. The advantages of carrying furnace temperatures higher than the present range are well recognized in fields as widely separated as glassmaking and steelmaking. This trend will not result in a shrinkage of the market for refractories.

The real vision that has led the refractories industry to consider its future as one of destiny is the belief that man has hardly begun to explore the field of high temperature chemistry. It may take only a single development in this important research field to yield an undreamed of market for refractories. Such a new process may even now be under trial.

In periods of intense research such as those accompanying wars it is commonly found that a process may fail of success because development has lagged in one or more of the essential elements. Thus a process requiring temperatures of 1800° C (3270° F) might fail if no refractory construction material were available which would withstand this temperature. It would indeed be ironical if an industry seeking new markets should fail to be ready when opportunity knocked. An important part of refractories research is aimed at developing refractories for these markets of the future which have not yet made their appearance.

Research Program

A research program with such an aim needs to start from a broad base. High refractoriness, the property of remaining solid to high temperatures without melting, is possessed by relatively few minerals but by a rather large group of compounds produced by industrial processes. Even if we set up the rigid requirement that the melting point must be above 1800° C, there are still almost twenty chemical elements yielding compounds which can qualify.[3] This select group does not include the familiar fireclay and silica (melting point 1713° C) refractories which are the backbone of today's industry. In their listing which appears in Table I it will be noted, however, that certain elements, notably aluminum, magnesium, and chromium form compounds which are familiar as refractories of excellent quality. In fact, refractories of these three types, produced commercially or experimentally, have withstood a temperature of

[1] *Fortune*, March 1945, p. 196.

[2] W. B. Boggs, J. N. Anderson, and W. L. Stevens, *The Noranda Smelter from 1939 to 1945*. Canadian Mining and Metallurgical *Bulletin No. 398*, June, 1945, 402 pp.

[3] Chiefly to keep the study within bounds, no consideration is given in the following discussions to carbon as a refractory nor to the nitrides, carbides, and borides. Many of these are known to be unstable in an oxidizing atmosphere.

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Fig. 1. At 1800°C, even some "super" refractories fall by the wayside.

1800° C with little adverse effect.

Each of the elements listed in Table I produces an oxide whose melting point exceeds 1800° C. Also, as indicated, many of these oxides may be compounded with magnesia, zirconia, titania or silica to form other compositions meeting this specification.

Table II shows the approximate value of the raw material required for a 9-in. straight (9 x 4.5 x 2.5-in.) of each oxide. Brick of this size selling for as much as a dollar are no longer a novelty. However, refractory compounds so expensive that materials for a single brick would cost more than ten dollars would seem to eliminate themselves for furnace construction, although the expense might be well justified for special small products such as burner tips. These include the oxides of beryllium ($25.00), thorium ($185.00), zirconium ($14.00 for 97 per cent purity), cerium ($17.00), and cobalt ($29.00). However, each of these oxides except cobalt oxide has been used for crucibles and other refractories of small size. It should be noted that most of these more expensive materials are available in such small tonnages that the entry of a new large user into the field would possibly cause prices to rise.

Views on those refractory compounds which may now be dismissed because of lack of supply (and high cost) are possibly subject to future revision. This applies to cerium, thorium, hafnium and particularly to beryllium. At present there are only ten chemical elements, having refractories interest, produced in such abundance as to suggest that brick could be made in quantity from their compounds, regardless of cost. These are magnesium, aluminum, zinc, titanium, zirconium, barium, strontium, calcium, chromium, and nickel.

In research on the development of these super refractories three considerations are basic: (1) only materials of highest purity should be used; (2) the brick and probably the raw material will almost surely require firing at 1650°C or higher to remove shrinkage; (3) special test methods including reheat tests at a minimum of 1800°C are needed for evaluating results.

The acceptance of the first point is necessary in view of experience with magnesia which melts at 2800°C but which in the presence of less than 10 per cent impurities may fail under load of 25 psi. at 1450°C. Zirconia and spinels (including chrome ores) are other highly refractory compounds for which extensive studies have shown high purity to be necessary. One exception might be taken to the view that high purity is an inescapable requirement; if the major impurity can be converted to a secondary mineral of high refractoriness, its removal would not be necessary. Thus the chrome refractories in which the silicate impurities have been converted to the refractory compound forsterite ($2MgO.SiO_2$, m.p. 1890°C) are examples now in commercial use. One product of this type, now undergoing trials in roofs of open-hearth steel furnaces, probably shows the most pronounced high temperature volume stability of all refractories available. It shrinks less than one per cent in volume on reheating at 1800°C.

The data in Table II showing the weights of 9-in. straights of the various oxides are of considerable interest. Those accustomed to handling silica brick which weigh 6 lbs. each would receive the surprise of their

(*Continued on page* 532)

TABLE I

MELTING POINTS IN DEGREES CENTIGRADE

Element	Oxide	Aluminate or mixture of oxide with Al_2O_3	Compound or mixture of oxide with MgO	Zirconate or mixture of oxide with ZrO_2	Titanate or mixture of oxide with TiO_2	Silicate or mixture of oxide with SiO_2
Magnesium	2800	2135 *	—	2150	1840	1890
Aluminum	2050	—	2135	1910*	1860	1810
Zinc	1975**	1950	No data	1810*	1830	(1510)
Titanium	1825	1860	1830	(1750) *	—	(1540) *
Zirconium	2690P	1910*	2150	—	(1750) *	2430
Barium	1925H	2000H	(1500) *	2650	No data	(1700)
Strontium	2430H	2015H	1935*	2800	No data	(1580)
Calcium	2570H	(1765) H	2360*	2550	1840	2130
Chromium	3000R	2800*	3000*	2320*	No data	No data
Nickel	1990R	2020	1990*	No data	No data	(1725) *
Cobalt	1935PR	1960	1935*	(1730) *P	No data	(1725) *
Beryllium	2530P	1820 (?)	1955*	2200*P	1810	(2000)
Cerium	2600P	1885	2250*	2400*P	(1500) *	No data
Thorium	3050P	1910*P	No data	2690*P	(1640) *	No data
Hafnium	2810P	No data	No data	No data P	No data	No data
Lanthanum	2320P	1870*	2030	2300	—	—
Uranium	2180P	—	—	—	—	—
Yttrium	2410P	—	—	—	—	—

Notes: The letters P, H, and R are to suggest that the principal limitations are price, hydration and reductibility, respectively.
Melting points falling below 1800 deg. C are given in parentheses.
If two oxides combine to form more than one compound, the data represent the more retractory one.
*No chemical compound. In such instances the minimum melting point is given if known.
**Volatilizes readily.
The chief reference paper for melting points was "Melting and Transformation Temperatures of Mineral and Allied Substances," by F. C. Kracek, Section II of *Special Papers No. 36*, Geological Society of America, *Handbook of Physical Constants*, edited by Francis Birch, pp. 139-74 (1942).

TABLE II

DATA ON REFRACTORY OXIDES

Element	Density of Oxide	Cost per lb.	Estimated Weight of 9" brick in lbs.	Cost of Material in 9" brick
Beryllium	3.0	$ 4.00	8.2	$ 25.00
Magnesium	3.6	.05	10.0	.50
Zinc	5.5	.075	15.0	1.10
Strontium	4.7	.50	12.9	6.50
Barium	5.7	.10	15.6	1.56
Calcium	3.3	.005	9.0	.05
Aluminum	4.0	.055	10.0	.55
Cerium	7.6	.82	20.8	17.00
Thorium	9.7	7.00	26.5	185.00
Titanium	4.9	.09	12.4	1.10
Zirconium	5.7	.90*	15.6	14.00
Yttrium	4.8	12.50	13.1	164.00
Lanthanum	6.5	14.00	17.8	250.00
Hafnium	9.7	—	26.5	—
Chromium	5.0	.25	13.7	3.40
Cobalt	5.7	1.84	15.6	28.60
Nickel	7.4	.35	20.0	7.00
Uranium	5.6	3.00	15.3	46.00

* Zircon, the silicate, is much cheaper than the oxide.

FIBERGLAS-REINFORCED PLASTIC PARTS REDUCE TOOLING COSTS

The experience of the aircraft industry has demonstrated that material reductions in tooling costs can be effected by the use of Fiberglas-reinforced plastics for the fabrication of parts. Because use of the glass-reinforced plastics eliminates the need for expensive metal dies and jigs, the economies are particularly impressive where design changes occur fairly frequently, where complex contours are involved, and where the number of parts produced runs into the hundreds or thousands rather than into the millions.

Use of Fiberglas-reinforced plastics for the fabrication of aircraft air ducts provides an illustration of the procedure employed. The first step is the preparation of the form blocks. A plaster of Paris cast is made of a wood pattern of the part. A slush-molded core is then lifted from the cast. This is used as the form over which the resin-impregnated Fiberglas fabric is laminated. The hollow plaster core is insulated from the resin with cellophane, or by a coat of lacquer followed by a coat of polyvinyl alcohol solution.

The required number of pieces of Fiberglas cloth are then trimmed to fit the form block. In cases of extreme compound contour, flutes are cut in the cloth to prevent wrinkling. A piece of the cloth is wrapped on the form block and the resin is brushed into it. Successive pieces of the cloth are added and brushed with the liquid resin until the desired thickness is obtained.

Because of the very low pressures required to form glass-plastic laminates with the new low-pressure contact resins, use of a vacuum bag in combination with an oven is rapidly becoming standard practice for curing the molded laminate. In molding prototypes of parts at the laboratories of Owens-Corning Fiberglas Corporation, transparent compar, a vinyl resin derivative developed by Resistoflex Corporation, is one of the materials employed for the bag.

The assembled Fiberglas-reinforced plastic hot air duct manufactured by Toyad Corporation, Gardena, California, for Hughes Aircraft Company.

Low-pressure reinforced plastics lend themselves to fabrication of undercut, hollow and complex parts. Illustrated is an unassembled Fiberglas-reinforced plastic hot air duct manufactured by Toyad Corporation, Gardena, California, for Hughes Aircraft Company. Use of reinforced plastic for such parts results in material savings in the time, tooling and labor that would be required to make the parts out of metal.

The form block, bearing the laminate formed to the desired shape, is set in the compar bag. Since the compar is water soluble, the open end can be sealed by moistening the edges and pressing them together. A hole is cut in the bag for the installation of a valve, or, instead of using a bag, the form block and laminate can be placed on a table, and covered with a sheet of compar fitted with a valve. A vacuum seal is obtained by clamping the edges of the sheet to the table.

Whether the bag or the sheet is used, the compar is wrinkled to conform to the shape of the laminate and the air is exhausted with a vacuum pump. The resulting

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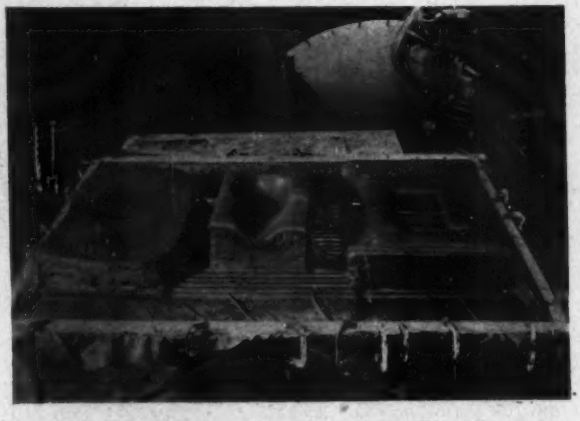

An example of the molding operation. The illustration shows three laminates of different shapes than aircraft ducts after air has been evacuated. As the pressure is increased, excess resin and air pockets are squeezed out of the laminates. The table is then rolled into the oven to complete polymerization of the resin at about 180 degrees F.

INVENTIONS AND INVENTORS

A Summary of Patents of Interest to the Glass Industry Issued During September

Compositions

A glass composition was invented by Alexis G. Pincus, assignor to the American Optical Co. This is disclosed in patent No. 2,381,925. Ordinary glass is open to attack by hydrochloric acid which causes a white film. By using aluminum metaphosphate and zinc oxide, a glass is produced which retains its polish to a much greater extent.

Another glass composition is found in patent No. 2,382,056, assigned to Corning Glass Works by Harrison P. Hood. The object of this composition is to produce a glass having good transmission of ultraviolet light having a wave length of about 185 mμ.

C. R. Austin and J. D. Sullivan, of Columbus, Ohio, have assigned their patent No. 2,382,282 to Battelle Memorial Institute. This patent discloses a selenium ruby glass and it is a continuation of their earlier patent No. 2,309,070. This glass is said to be superior in color and less expensive than other types of ruby glass.

Furnaces

An improved tank for drawing sheet glass has been invented by George D. Campbell of Tarentum, Pa.

This invention is shown in patent No. 2,384,073 which

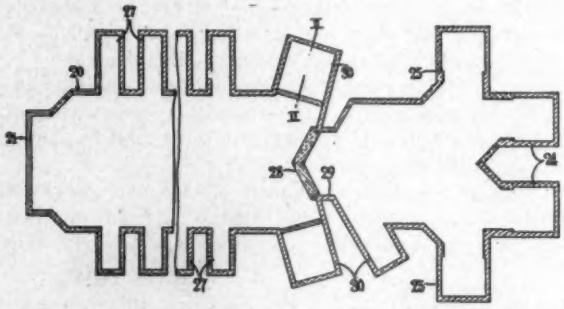

Fig. 1. Campbell, 2,384,073: Improved tank for sheet glass.

is assigned to Pittsburgh Plate Glass Company. Fig. 1 is a plan, in section, of a tank having drawing chambers 24 for the end of the tank, and side drawing chambers 25. The batch is charged in the end 21 and after it melts, it flows to the right in the figure to the drawing chambers.

It has been known that the better quality glass flows down the central position of the tank to the front drawing chambers 24. Any contaminated or unrefined glass tends to pass down the side walls to the side drawing chambers 25. In order to overcome this difficulty, Mr. Campbell provides what he calls "skim kills" 30. A floater 28 tends to direct the glass of inferior quality towards these two skim kills. The entrance to each kill is partially closed by a refractory bridge 40. This bridge is submerged below the surface of the glass and spaced from the bottom of the kill. Several modifications of this bridge are shown in the patent but the general principle is the same in that the glass on the surface flows over the bridge into the kiln and out below the bridge into the tank. This construction improves the quality of the glass by reducing the seeds, blisters and ream.

William A. Moorshead of London has assigned his United States patent No. 2,385,529 to the United Glass Bottle Manufacturers, which is a British company. This invention relates particularly to the melting section of the furnace. The object of the invention is to melt glass more efficiently than has been possible heretofore. Fig. 2 shows a sectional plan of the furnace. The primary heating section is indicated by a, and the refining section is shown at b. The working end e is connected by a throat through the bridge wall d. The refining section b is preferably about two-thirds of the total melting area required. The batch is fed in at the left end of the drawing and is melted as it passes to the working end. The fire is admitted through the ports j and the flame

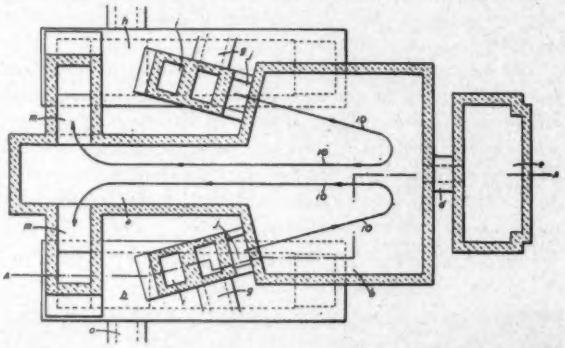

Fig. 2. Moorshead, 2,385,529: Glass melting furnace.

takes a direction indicated by the lines 10 to the exhaust ports m. This construction reduces the temperature of the flue gas and increases the efficiency of the furnace.

Feeding, Forming and Shaping

Theodore H. Sloan, of Charleroi, Pa., has assigned his patent No. 2,384,498 to G.M.S. Corporation of Pittsburgh, Pa. This patent shows a forming machine having a parison mold table carrying eight molds and a blow-mold table having corresponding molds. The particular novelty of this invention is in the drive mechanism which includes two clutches by which either the forming machine or feeder, or both, may be shut down independently, and two Geneva drives, one for each table. The Geneva drives include means by which the time of dwell of the tables may be varied without changing the speed of rotation.

As shown in Fig. 3, the machine is driven through a pulley 29. A train of gears is provided to drive a shaft running to the feeder which is not shown in this drawing. A clutch 32 is provided, by which the forming machine may be shut down and second clutch 52 is arranged to shut down the feeder. The pulley 29 is connected through a train of gears as shown in the drawing to

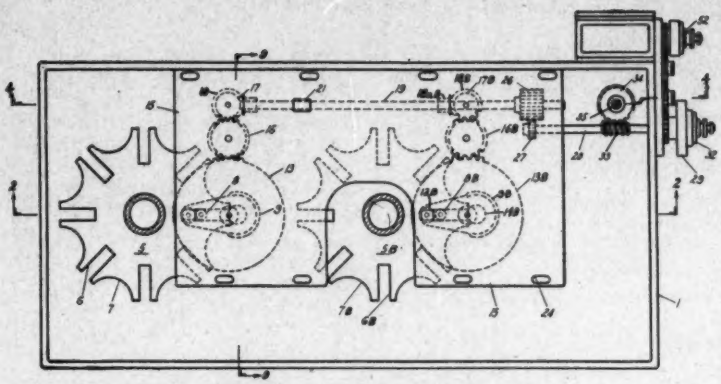

Fig. 3. Sloan, 2,384,498: A two-table forming machine.

drive two gears 13 and 13B. Below each of these gears is the arm for driving the Geneva plates 5 and 5B which are directly connected to the two central columns of each table. The gear and the arm are mounted on separate shafts, one of which is shown at 14B. The connection between the gear and the Geneva arm is made by a radial slot in the top of the Geneva arm which is engaged by a roller carried by the gear. A plate 15 is provided, carrying the gears 13 and 13B. Provision is made for shifting this plate laterally so that the arms and the gears may be positioned concentrically or eccentrically. As these two parts are moved to eccentric position, the speed of the Geneva arm will not be uniform. Therefore, the period of dwell of the Geneva and the mold tables can be varied in accordance with eccentricity of the gears 13 and 13B and the Geneva arm.

John P. Schellhaus, Jr., assigned patent No. 2,385,302 to Owens-Illinois Glass Company. This machine for making stemware is of the rotary type, having six radial arms which are intermittently rotated to bring the arms successively to a series of operating stations where operations are carried out as shown in Fig. 4. At station A a blow pipe 70 is shown carrying a hand blown bowl 72. The machine then lifts the blow pipe, carrying it to station B, and lowers the bowl into contact with a continuously rotating block 88. This brings the bowl into alignment with the blow pipe. The next step of the machine carries the blow pipe to station C, where a stem is pressed in the mold 95. The blow pipe is lowered, bringing the bowl into contact with the pressed stem, which parts weld together.

The glass for the stem is pressed upward into the mold by a plunger 151. The mold and blow pipe are then lifted so as to permit a shear to sever any excess glass

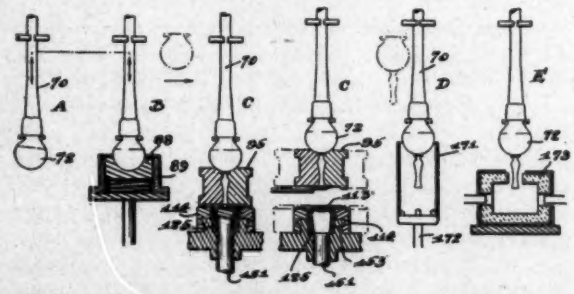

Fig. 4. Schellhaus, 2,385,302: Owens-Illinois machine for making stemware.

which may project below the mold.

The blow pipe with the attached bowl and stem is then lifted and moved to station D, where it may be lowered into a cooling chamber 171.

The machine then indexes to station E, where the stem is lowered into a glory hole 173. The stem is reheated and an operator removes the blow pipe and attaches the foot by the usual hand method.

Glass to form the stem is hand gathered and deposited in a transfer cup 125, shown at the two stations indicated by C.

It is stated that this machine greatly reduces the hand labor required in making articles such as goblets and that the articles are much more uniform in size and shape than when made by hand.

Patent No. 2,383,556, an invention by Harry M. Louden of Columbus, Ohio, and Cecil McCreery of Muncie, Indiana, has been assigned to the Owens-Illinois Glass Company. This is a mold lock for holding the two halves of a pressed mold together during the press-

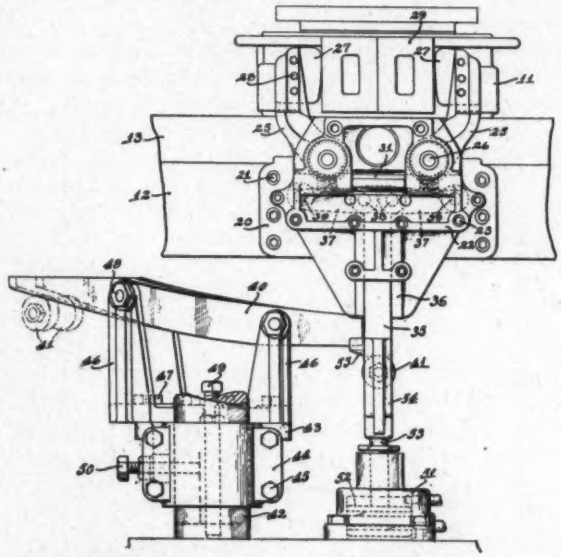

Fig. 5. Louden and McCreery, 2,383,556: Mould lock for glass block press.

ing operation and up to a point just before the take-out. An individual locking mechanism is provided for each mold as shown in Fig. 5. The invention is an improvement on patent No. 2,304,736, granted to the same inventors.

As shown in the figure, a mold table 12 is rotated intermittently to bring the molds to a series of operating stations. The mold halves are provided with extensions 29 which are engaged by interchangeable holding pads 27, mounted on arms 25. These arms are pivoted at 26 and a toggle mechanism is provided, actuated by a vertically sliding bar 35. As the mold approaches the pressing station, a pair of rollers 41 engage a cam 40 which moves the bar 35 down into clamping position. The final clamping movement is provided by a piston and cylinder 51. This final movement brings the toggle

actuating the arms 25 to slightly below the dead center line so that when the mold advances to the next station, the arms 25 remain in clamping position. The molds may then be advanced through three cooling positions while they remain locked. Just before reaching the take-out position, the rolls 41 on the slide bar 35 engage an unlocking cam somewhat similar to the cam 40 but working in the opposite direction, so that the mold halves are unlocked and the arms 25 swing downward so as to permit the molds to be opened.

Miscellaneous Processes

A new method of making circular type spirit levels is shown in patent No. 2,385,071, an invention of James Geier of Troy, N. Y. This patent proposes to make a circular level by first forming an open top cup, then heating the cup and forming a projecting tip with a small plunger, then grinding off the point of the tip to provide an opening in the bottom or side of the cup, and then sealing on the curved cover. This provides a vessel closed except for the small hole through the tip. By vacuumizing this container, alcohol or other liquid may be drawn into it so as to form a bubble of the desired size. The opening through the tip is then sealed by a flame.

Lynn C. Goodale of Newark, N. J., has assigned patent No. 2,384,833 to Federal Telephone and Radio Corpora-

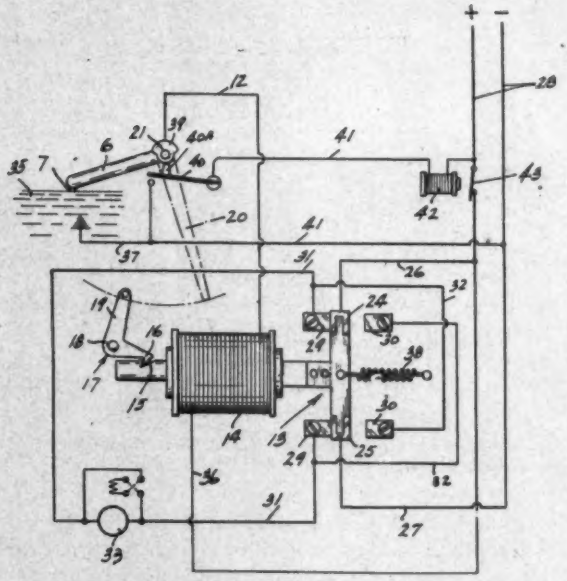

Fig. 6. Holdman, 2,380,436: Glass level recorder.

tion. This method comprises the steps of sealing a glass bead onto a tungsten rod, providing a hole slightly larger than the rod, in the part to be sealed to the bead, and then applying heat from above and to the bead, so that the part to be welded drops into contact with the bead and an effective seal is made.

This Glass Level Recorder is the invention of Robert E. Holdman of Portland, Ore., and is shown in patent No. 2,380,436. In general, this recorder comprises a feeler or level indicator which reciprocates toward and from the surface of the glass. A mechanism is provided

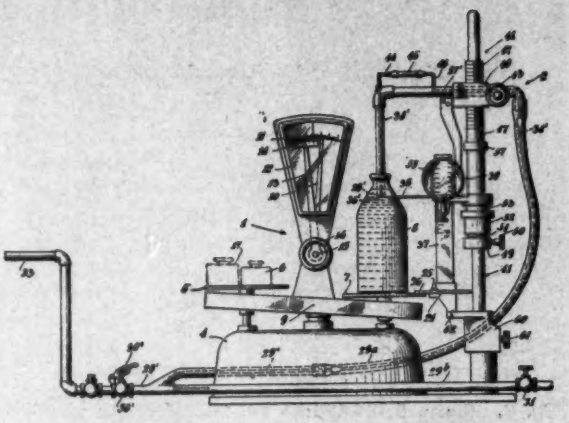

Fig. 7. Nairn, 2,383,269: Anchor Hocking device for testing the weight of capacity of bottles.

for making a record showing the variations in the glass level as found by the feeler mechanism. It is stated that this mechanism will indicate and record variations in glass level down to 1/100 of an inch.

As shown in Fig. 6, an arm 6 carries a platinum contact 7 which engages the surface of the glass, completing an electrical circuit which sets into operation a recording mechanism not shown in the figure. When the circuit is completed through the wiring shown in the diagram, a reversible motor, indicated at 33, changes its direction of rotation so that the arm of the feeler 6 is lifted, until such time as an arm 20 engages a bell crank 17 which again reverses the direction of rotation of the motor 33.

Safety devices are provided, comprising a cam 39 and a switch blade 40 which throws the power off in case of an abnormal glass level. Provision is made for water cooling the parts subject to heat, and various other safety devices are provided.

George P. Nairn, of Salem, N. J., is the inventor of a patent No. 2,383,269 assigned by Anchor Hocking Glass Corporation. The object of the invention is to provide an accurate and quick-acting device for testing the weight and capacity of bottles shown in Fig. 7. A balance is provided, having a table 7 on which the bottle to be tested is placed. A platform 5 is for the support of counterbalancing weights. The smaller weight 6 corresponds to the weight of the bottle in ounces avoirdupois. A pointer 10 gives the plus or minus weight of the empty bottle.

After the weight of the empty bottle is determined, it is filled to the fill line and it is again weighed in units of fluid ounces. A weight 17 is then placed on the platform and this weight should exactly counterbalance the weight of the bottle when properly filled. When the weight of the empty bottle has been determined, as indicated by the pointer 10, a movable scale 14 is turned so that zero on the scale coincides with the pointer. The plus or minus capacity of the bottle is read on the scale 14.

A valve 30′ controls the admission of water to the bottle through the pipe connections shown in the drawing. The bottle is slightly overfilled and when the valve 30′ is closed, a syphon acts to bring the water in the

(*Continued on page* 534)

Research Digest

Practical Interpretations of Glass Technology

Studies in the Distribution of Temperature Through Molten Glasses in a Tank

The importance of obtaining accurate, quantitative information based on experimental evidence on the temperature distribution in a mass of molten glass in a tank furnace is well known to the glass technologist. In the February, 1945, issue of the *Journal of the Society of Glass Technology*, Halle and Turner present Part I of such a study and discuss some laboratory measurements on some commercial glasses obtained in a model tank furnace.

The glasses were melted in an experimental rectangular furnace of 12 inches length, 8 inches width and 6 inches depth, with an effective glass depth of 5 inches, provision was made for measuring the rate of gas and air flow to the furnace, the colorific value of the gas, and for filtering the gas and air. The tank was constructed of laboratory-made refractory bricks of uniform properties. The glasses tested comprised four commercial soda-lime-silica glasses of known composition, in three cases containing added coloring constituents to yield amber, dark green and bluish-green glasses, the other being colorless.

The effect of surface temperature on the temperature gradient through the central plane of each of the glasses was tested by carrying out measurements at surface temperatures of 1400°, 1300°, 1200°, 1100°, 1000° and, in one case, at 900°, respectively. (The Fahrenheit equivalents of these temperatures are as follows: 2552°, 2372°, 2192°, 2012°, 1832° and 1652° F.) A study of the results obtained showed first, that for each glass the temperature gradients for the various surface temperatures are practically parallel. From this fact, it can be concluded that the diathermanous characteristics of the glasses, measured in degrees temperature drop per inch depth, underwent little change over the temperature range studied.

The effect of the sidewalls on the temperature distribution in the tank for the colorless, amber and dark-green bottle glasses was studied by determining the temperature gradients simultaneously at the center of the tank and at distances of 0.5 inches from either side-wall at points lying in a cross-sectional plane through the center of the tank. As it is well known that in many cases the operation of tank furnaces containing dark-colored glasses has been considerably improved by the application of insulation to certain parts of the furnace, particularly the bottom of the tank, the throat and the lower half of the sidewalls, the furnace was insulated and the effect of the insulation on the temperature distribution also studied. The results obtained showed that for surface temperatures of 1400° (2552° F) the differences in temperature at the center and near the sidewalls were 65° C for the colorless, 127° C, for the amber and 175° C for the dark green glass when the tank was not insulated, and 57° C, 132° C and 195° C, respectively, when insulated. The application of insulation had the expected effect of reducing the vertical temperature gradients in all cases and raising the general level of temperature throughout the mass of glass by about 100° C, without affecting the fundamental differences in temperature distribution between the different glasses.

In an attempt to obtain some quantitative measure of the relative diathermancies in the molten state of the various glasses investigated, the approximate overall percentage heat transmission for each glass was calculated on the basis of a heat balance drawn up for the model tank furnace. To obtain conditions of constant heat flow, the gas consumption was maintained constant at 12 cu. ft. per minute, the temperatures developed at the center of the glass surface being 1400° (2552° F), 1435° (2615° F) and 1462° (2665° F) for the colorless, amber and dark green glasses. The overall heat transmissions in the molten state were 60 per cent for the colorless, 49 per cent for the amber and 37 per cent for the dark green glass. These results apply only to the experimental conditions employed; in particular, it must be remembered that the area considered in determining the heat transmission is small. The values cannot, therefore, be claimed to be absolute, but they do express, in a quantitative manner, the relative diathermancies of the different glasses.

The results of this investigation confirm the results previously reported; namely, that temperature gradients through masses of colorless glass are considerably lower than corresponding gradients through colorless glasses. Further, a marked difference in temperature distribution exists between different colored glasses, depending on the type, the concentration and the state of oxidation of the coloring oxides present. In these experiments, no mechanical flow existed. The regular character of all the temperature gradients determined in the present work, indicate that thermal currents can hardly play an important part in the heat transfer from the surface of the mass downwards.

A consideration of the viscosity characteristics of these glasses also shows the predominant effect of diathermancy on heat distribution. A discussion on the effect of thermal conductivity indicated that it would be difficult to explain the large differences in temperature distribution between molten glasses of different color on the grounds of thermal conductivity.

This investigation also confirmed the earlier result; namely, that the fuel required to maintain the surface of the glass at a temperature of 1400° C decreased in the order: colorless, amber, dark green glass. The gas consumption in cu. ft. per minute being 12.0 for the colorless, 10.5 for amber and 9.5 for dark green glass.

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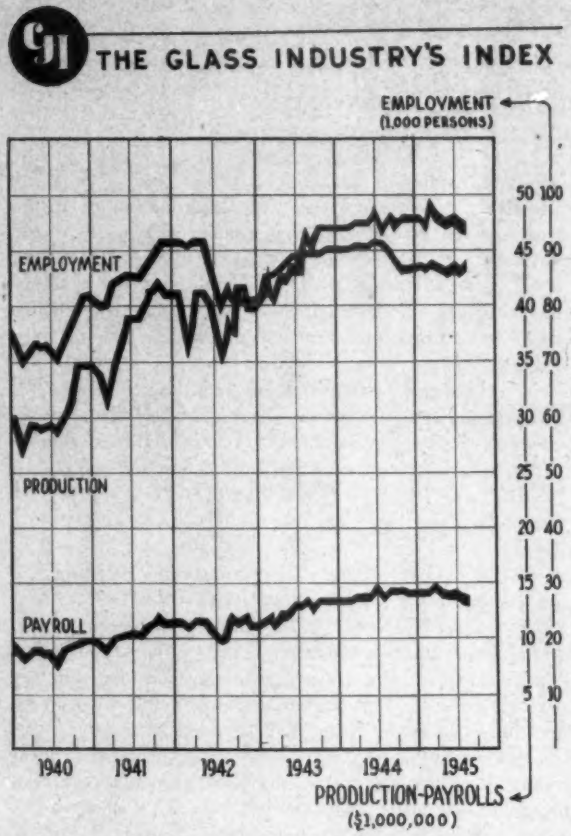
CURRENT STATISTICAL POSITION OF GLASS



Activity in the glass industry for the month of August, as reported by the Production Index, dropped about 1½ per cent from July figures to a total of $45,300,000. August 1944 production was reported at $48,000,000 or about 12 per cent over August 1945. Output for the January-September 1945 period totalled $377,300,000 which is slightly lower than the $381,000,000 for the same period in 1944.

Employment and payrolls: The total number of persons employed during August was 87,200. July 1945 totalled 86,300 persons and August 1944 reported 90,000 persons.

Payrolls for August dropped from $12,500,000 reported for July to $12,300,000. This represents an approximate 1 per cent decrease. August 1944 reports showed estimated payrolls to be $14,500,000—approximately 12 per cent more than for August this year. Glass manufacturers have paid out approximately $108,000,000 in salaries during the first nine months of 1945.

Glass container production for September 1945 was reported to be 8,991,084 gross. This is a decrease of about 3 per cent from August and approximately 15 per cent more than that reported for September 1944. Production for the first nine months of 1945 totals 78,014,444 gross—an increase of over 6 per cent for the corresponding period in 1944.

Shipments of glass containers during September were reported at 8,949,888 gross—a decrease of close to 6 per cent under August 1945 and an increase of slightly over 18 per cent above September 1944. Shipments for the three quarters of 1945 total 79,600,184 gross—an approximate 8 per cent increase over the same period for 1944.

Inventories on glass containers for September were reported at 3,816,619 gross. This represents a drop of about 3 per cent from August 1945 and a drop of about 26 per cent from September 1944.

Plate glass production for September was reported by the Hughes Statistical Bureau to be 10,353,520 sq. ft. as compared to 8,965,701 sq. ft. reported for the preceding month. The September figure represents an approximate 15 per cent increase over the August figure. September 1944 plate glass production totalled 9,045,516 sq. ft., or a decrease of about 14 per cent under September 1945. The three-quarter period of 1945 showed

(*Continued on page* 524)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures Are in Gross)

		Production Sept., 1945	*Stocks Sept.*, 1945
Foods; Medical & Health Supplies; Chemicals, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	3,302,972	1,761,518
	Wide Mouth	2,963,362	937,698
Dairy Products		310,840	182,855
Home Canning		201,595	205,218
Beverages, Returnable		507,120	297,918
Beverages, Non-returnable			
Beer, Returnable		392,884	95,149
Beer, Non-returnable		326,124	56,110
Liquors		763,681	199,225
Wines		159,112	72,624
Packers' Tumblers		63,394	8,294
Total		8,991,084	3,816,619

GLASS CONTAINER SHIPMENTS

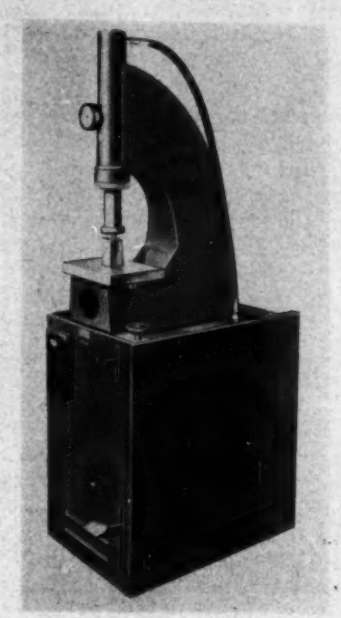
(All Figures Are in Gross)

Narrow Neck Containers	*Sept.*, 1945
Foods	1,161,692
Medical & Health Supplies	962,828
Chemical, Household, Industrials	582,780
Beverages, Returnable	443,814
Beverages, Non-returnable	
Beer, Returnable	429,241
Beer, Non-returnable	325,739
Liquors	714,887
Wines	153,470
Toiletries & Cosmetics	598,499
Sub-Total (Narrow Neck)	5,372,950
Wide Mouth Containers	
Foods	2,341,646
Dairy Products	304,157
Home Canning	140,981
Medical & Health Supplies	274,155
Chemical, Household, Industrials	106,360
Toiletries & Cosmetics	133,520
Packers' Tumblers	76,576
Sub-Total (Wide Mouth)	3,377,395
Total Domestic	8,750,345
Export Shipments	199,543
Total Shipments	8,949,888

NEW EQUIPMENT AND SUPPLIES

NEW LINE OF HYDRAULIC PRESSES

The Munton Manufacturing Co., Franklin Park, Illinois, has recently brought out a line of positive self-contained hydraulic presses adaptable to all sizes and types of shops. These



presses are available with self-contained motor drive for production work, foot operated, either mounted with bottom of press open or flush, as illustrated.

The hydraulic presses are available in capacities of 4½, 7, 10, 15, 20 and 25 tons with means to limit pressures being applied and a holding valve may be used to enable the press to be used for certain molding or glue weld operation which causes ram to be held under pressure until lever is tripped.

Rams are interchangeable on the various presses permitting greater speeds with lower pressure rams or higher pressures at lower speeds.

POWER-FLEX CONVEYING UNIT

Island Equipment Corporation, 101 Park Avenue, New York, N. Y., has recently placed on the market a small powered belt conveyor unit in 10′, 5′ and 3′ lengths. These units can be coupled together to make as long a conveyor system as desired and can be twisted to form any shape. Two sections will make a 30° turn; three sections, 60°; and four sections, 90°.

Push button regulation quickly controls the entire system from one end to the other, and each unit is capable of carrying a distributed load of 400 pounds. The belts of the units are available in 12″, 16″ and 20″ widths.

AEROTEC AIR & GAS CLEANER

Aerotec Company, 61 Westchester Avenue, White Plains, N. Y., has developed a new type air cleaning tube used in multiples up to any desired capacity. The tube has a high precipitating efficiency and develops no pressure build-up.

Clean air is exhausted from central tube while the dust is precipitated from the bottom. It is being used for reclaiming valuable powders, intaking on Diesel and gas engines, cleaning dust laden air in industrial and chemical plans and other applications requiring high collection efficiency.

CATALOGUES RECEIVED

North American Philips Company, Inc., 100 East 42nd Street, New York, N. Y., has recently made available a 16-page illustrated booklet covering basic theory, principles and applications of X-ray diffraction.

The booklet explains how X-rays are diffracted, the technique of powder identification, how various types of film-type equipment work, organic compounds, catalysts, high polymer work and heat exchanger problems, to mention a few subjects covered.

The LaBour Company, Inc., Elkhart, Indiana, has recently issued a bulletin featuring the Type G pump.

The booklet is illustrated throughout and covers the priming principle, construction, application, installation, etc. A chart giving information on friction of water in pipes is included.

The Bellows Company, Senacon Division, 861 East Tallmadge Ave., Akron 10, Ohio, has issued a bulletin covering the company's air motors.

Various models are featured in dimensional drawings and illustrations show the operation of the motors. Other bulletins are offered covering other Bellows air power units.

Air Reduction Sales Company, 60 East 42nd Street, New York 17, N. Y., has published a price list and catalog of Airco gas welding and cutting supplies and accessories.

The 16-page booklet illustrates, describes, gives prices and engineering data on welding rods, brazing and welding flux, hose, brazing alloys, goggles and spectacles, gloves for gas welding and cutting and spark-lighters and tips.

Numerous photographs and sketches supplement the text and a complete list of Airco offices throughout the country is included.

The Thermix Engineering Company, First National Bank Building, Greenwich, Conn., project and sales engineers for the Aerotec Company of White Plains, New York, has recently made available a bulletin, No. 101, dealing with the problem of efficient fine dust collection, particularly in the range 325 mesh screen or finer.

The booklet includes precipitating tests on various dusts in the industrial field, various powdered foods and chemicals. In addition, the sizes available in Aerotec units from single tubes to 100,000 C.F.M. are shown.

Askania Regulator Company, 1603 S. Michigan Ave., Chicago 16, Illinois, has issued a 12-page booklet entitled, "Askania Automatic Control for The Glass Industry."

The booklet, known as Bulletin 124, covers automatic control, furnace pressure or draft control, combustion control and heat input. It is well illustrated and features a diagram of Askania automatic control on a modern glass tank and a blueprint of the Askania automatic reversal control system.

Cambridge Wire Cloth Company, Cambridge, Maryland, has published Bulletin 80 featuring Cambridge wire cloth, fabricated products and copper screens for filter use.

The bulletin illustrates various degrees of meshing of both the wire cloth and screening.

In the same bulletin, individual catalogs are offered featuring "Cambridge Wire Cloth and Metallic Screen" and "Cambridge Conveyor Belts."

Owens-Corning Glass Company, Toledo, Ohio, has recently published a review giving the history of Fiberglas and its part in the post-war period.

Entitled, "Fiberglas . . . An Engineering Material," the contents embrace the development, manufacture, properties, war uses of Fiberglas, post-war forms and uses, Fiberglas materials in medicine and Fiberglas Research.

Also reviewed is Fiberglas thermal and acoustical insulation, Fiberglas fabrics, Fiberglas air filters and tower packing and Fiberglas mat. Copies of this complete discussion of Fiberglas are available upon request.

Baldwin-Duckworth Division of the Chain Belt Company, Springfield 2, Mass., has made available an eight-page folder featuring Baldwin-Rex Roller Chain Belts.

A detailed description of the roller chain features is presented, in addition to a table of specifications of the more popular sizes with their list prices.

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a total of 76,281,143 sq. ft., which represents about 2 per cent less than the 78,200,911 sq. ft. produced during the January-September period in 1944.

Automatic tumbler production for the month of September is reported to be 5,394,230 dozens. This is slightly less than reported for August and about 17 per cent less than for September 1944. Shipments for September are totalled at 5,353,617 dozens, as compared to 5,451,780 for August and 6,290,460 dozens for September 1944. Finished stocks of automatic tumblers on hand at the end of September were 4,170,428 dozens which is slightly more than for August and about 41 per cent less than for September 1944.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware were reported at 2,583,014 dozens for the month of September. August reports showed a total of 3,189,780 dozens (about 18 per cent above September) and September 1944 figures were reported at 2,820,381 dozens which is slightly more than for September 1945. Total sales for the first nine months of 1945 are 36,049,144 dozens.

RESEARCH DIGEST . . .

(*Continued from page* 521)

Tables I and II give some of the temperatures obtained at various positions in the furnace when insulated and uninsulated and when the glasses were at a surface temperature of 1400° C.

TABLE I

UNINSULATED

Surface at 1400° *C.*

Glass Color	*Center*	*0.5 in. from Left-hand Side-wall*	*0.5 in. from Right-hand Side-wall*	*Average Bottom Temp.*
Colorless	1260°	1200°	1190°	1228°
Amber	1115°	985°	990°	1052°
Dark Green	930°	750°	760°	843°

TABLE II

INSULATED

Surface at 1400° *C.*

Glass Color	*Center*	*0.5 in. from Left-hand Side-wall*	*0.5 in. from Right-hand Side-wall*	*Average Bottom Temp.*
Colorless	1345°	1290°	1285°	1329°
Amber	1210°	1080°	1075°	1149°
Dark Green	1040°	840°	850°	943°

• Fred C. Abbott has been appointed manager of the New Products Division of the Pennsylvania Salt Manufacturing Company. In his new capacity, Mr. Abbott will organize the newly created Division to introduce and develop the sale of new industrial chemicals and specialties.

Joseph A. Pask, newly elected Chairman of the New York Metropolitan Section of A.C.S.

NEW YORK METROPOLITAN SECTION OF A. C. S. HOLDS FIRST MEETING

The first meeting of the newly formed New York Metropolitan Section of the American Ceramic Society, the 13th local Section, was held on October 17 at the Building Trades Employers Association, 2 Park Avenue, New York, N. Y. Attendance was most gratifying, eighty-four members being present.

After the informal dinner, the meeting was opened by Joseph A. Pask. The charter for the new Section was presented by C. Forrest Tefft, Claycraft Company, Columbus, Ohio, and president of the American Ceramic Society. In his presentation address, he stressed the need for research in all branches of the ceramic industry and pointed to the glass industry as a leader in this endeavor.

Charles S. Pearce, Associate Secretary of the A.C.S., offered congratulations and voiced the desire of the national officers to be of assistance to the Section in any way possible. Congratulatory letters and telegrams were received from eight other Sections.

The Nominating Committee, headed by Emerson W. Emrich, and composed of Robert M. Curts, Frank Fallon and Robert H. H. Pierce, Jr., presented its slate and the following officers of the New York Metropolitan Section were elected: Joseph A. Pask, Chairman; James D. Tetrick, Vice-Chairman; Perry C. McCollom, Secretary-Treasurer; and James B. Austin and C. C. Treischel, Councillors.

Two committees were announced and members were introduced. The Program Committee: Rexford Newcomb, Jr., Chairman, and William H. Coffeen, Robert Doran and Francis J. Williams. The Publicity Committee: Cyril B. Delgado, Chairman, and Nelson E. Wendt, Robert H. H. Pierce, Jr., and Frank Fallon.

Following the business meeting, James D. Tetrick introduced the speaker of the evening, Jan S. Irvine, Eastern Manager of Owens-Corning Fiberglas Corporation. In his introduction, Mr. Tetrick addressed the Section as "members of Local No. 13."

Mr. Irvine was particularly well equipped to handle his subject, "Fiberglas and Its Applications, War and Postwar." His connection with the company dates from its inception in 1931 and his work has taken him through the factory and laboratory.

In his talk, Mr. Irvine pointed out the almost limitless applications for fibrous glass, but readily outlined its limitations as well. Samples of the material were shown and after the talk, questions from the assembled members brought out many interesting points in the manufacturing process of Fiberglas and its possible applications.

No date has been set for the next meeting of the New York Metropolitan Section. However, Committee Chairmen and Section Chairman Pask will meet in the near future and announcement of the next meeting should be made soon thereafter.

PENN SALT ADDS TO RESEARCH STAFF

Pennsylvania Salt Manufacturing Company has recently announced four additions to its research and developmen staff.

Dr. E. B. Gunyou, formerly with the Production Division of WPB and Grasselli Chemicals Department of du Pont Company, will become assistant manager of the research and development department, and will be located at the company's Philadelphia office. Dr. Harry G. Walker will have charge of the development of new and improved agricultural chemicals. Dr. Walker was previously associated with the Ohio Agricultural Experiment Station and the Crop Protection Institute.

Dr. Thaddeus Parr, who has been appointed senior research entomologist, has formerly served with the Bureau of Entomology and Plant Quarantine, U. S. Forest Service and the Royal Swedish Experiment Station. Murray Zakheim has been transferred to the research and development department from the Defense Plant Corporation which is operated by Pennsylvania Salt Manufacturing Company.

SALES APPOINTMENTS AT BAILEY METER COMPANY

The appointments of W. E. Dueringer to the post of Assistant Sales Manager and H. E. Weaver to that of Proposition Department Manager have recently been announced by the Bailey Meter Company.

Both Mr. Dueringer and Mr. Weaver have been associated with the company for over 25 years and have contributed a great deal towards solving many problems in the application of metering and control equipment.

In his new position of Assistant Sales Manager, Mr. Dueringer will supervise the activities of the company's Proposition and Order Departments, and Mr. Weaver will head a staff of industry specialists.

GLASS-LINED STEEL SILO DEVELOPED

A glass-lined steel silo has been developed by the A. O. Smith Corporation of Milwaukee that is unloaded mechanically from the bottom and that will keep silage unspoiled in the same manner that food is preserved in vacuum sealed glass jars, by keeping it air-tight.

This glass-lined silo already has undergone extensive tests and following are some of the highlights. 1—Silage is removed through a 24-inch hopper opening at the bottom which is operated by an engine driven mechanism, reducing labor and hazard. 2—The engine feeds "burned out" air into the top of the silo to keep out the oxygen which moulds must have, thus eliminating spoilage. 3—The silo is about one-sixth the weight of a standard concrete silo. 4—The cost is comparable to a standard silo. 5—It is to be in production for the 1946 corn crop.

Wesley G. Martin, research engineer in charge of the farm equipment division of the A. O. Smith Corporation, discovered that in silos there were factors of spoilage, labor expenditure and hazard which, if corrected, would be of inestimable value to American agriculture. He had earlier developed a method of coating steel with a thin glass surface, a process on which is based the company's extensive manufacture of glass lined storage vessels, water heaters and other vessels for industrial use.

Martin wanted a silo that would do three things—resist corrosion, eliminate spoilage and do away with drudgery and hazard. He first tested some glass coated steel by burying it in silage for the winter. He found the glass unaffected by the strong silage acids.

The next problem was to prevent fresh air from getting into the silo. This could not be done if a man had to enter it every day to throw out silage. So engineers worked out a way to unload silage from the bottom. The result was a hopper type base with an engine driven mechanism which forces the silage out at the bottom, while the engine itself pumps "burned out" air into the top of the silo to prevent the entrance of oxygen-bearing air.

The last problem was the protection of the steel exterior from the weather, and that was easily solved by glass coating the outside, which eliminates any need for paint.

The mast extending into the silo is to prevent "bridging". The engine operates the mast, the blades that force the silage out of the hopper bottom and the worm gear that carries silage into the barn. It also pumps "burned air" to the top of the silo to force out oxygen-bearing air so that no spoilage can occur.

CHEMICAL INDUSTRIES EXPOSITION SCHEDULED

The 20th Exposition of Chemical Industries is scheduled to be held in Grand Central Palace, for the week of February 25 to March 2. The Exposition will feature raw materials, processing equipment and chemical products.

The Exposition, coming at a time when industries are in the midst of reconversion, will feature many new products and processes which had not been available due to wartime restrictions and other products and processes which had been shelved during the war years.

CORNING ADDS ANOTHER SOUTH AMERICAN PLANT

As the third addition to its South American expansion program, Corning Glass Works has announced the purchase of a substantial interest in Cristalerias de Chile, largest glass manufacturer in that country. While the majority control of the Chilean concern will be retained by the original owners in South America, Corning will be represented on the Board of Directors.

Corning began its South American expansion about two years ago with a similar purchase of Argentina's foremost glass concern, Cristalerias Rigolleau of Buenos Aires. Its second development was an investment in Brazil's leading glass company, Vidraria Santa Marina of Sao Paulo.

The Corning policy in developing South American resources has been to take a stake in established concerns and provide them with whatever technical knowledge and methods Corning can contribute. It is the plan of Corning officials to place at the disposal of the new Chilean acquisition furnaces and other equipment which will enable the plant to manufacture many of Corning's well-known glass products.

• The Thatcher Manufacturing Company has recently announced the election of F. Kingsley Rodewald to the Board of Directors. Mr. Rodewald is Vice President and Assistant to the President.

SOLVAY follows thru for industry

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GLASS-METAL SEALS . . .

(*Continued from page* 511)

members to a conductor is one employing high frequency heating described in a recent patent issued to Raytheon Mfg. Co.[12]. In this process, the vitreous member and conductor are arranged in juxtaposition (See Figure 7) in an atmosphere of dry nitrogen or other gas of low heat conductivity, the atmosphere being several pounds above atmospheric. Heat is then generated in the conductor by a high frequency coil on the outside, the sealing being done under the gas pressure.

Another patent to Federal Telephone & Radio[13] covers a method of sealing a previously glass-beaded rod through an aperture in a plate which is larger than the cross section of the rod, but smaller than that of the bead (See Figure 8). This involves positioning the rod vertically through the aperture with the top of the glass bead slightly below and spaced away from the aperture, and applying heat to the plate on the side away from the bead to soften the glass about the aperture so that it will drop onto and seal to the bead.

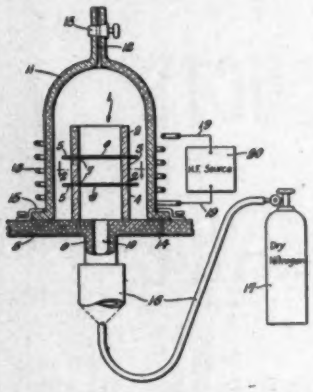

Fig. 7

Polan industries has announced the availability of heat resistant glasses for metal sealing purposes[14].

The mechanism of glass-metal sealing has been discussed at length by King[15] who discounted Weyl's theory of adherence through "oxygen bonds." In cases such as cobalt and steel enamels, he felt that a specific action was involved.

Testing

In the Marion Instrument Co. method of checking vacuum apparatus to insure hermetic sealing, the instruments, after sealing, are submerged in glass jars of alcohol and a vacuum of 25 inches is drawn. Absence of air bubbles indicates perfect sealing[16]. In one severe test, the instrument was dropped in a beaker of boiling brine, the test being conducted for two weeks without failure or permanent error in excess of 1 per cent. There were no leaks after a check by means of a vacuum test[17].

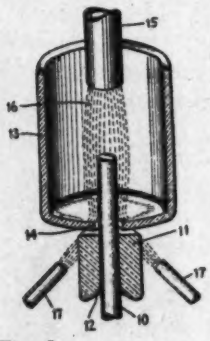

Fig. 8

Present government specifications require a moisture indicator having a reversible color change to be placed in the instrument so as to be visible from the outside and indicate whether the moisture concentration within is in the dangerous zone. One firm is now marketing such color indicators in the form of strips on tape, the colored strips being peeled off the tape and attached directly to the dial by means of its sticky surface.

Conclusions

This war-accelerated development of hermetic sealing has already achieved considerable popularity and there is no doubt that it is here to stay. With improvements in manufacture and large scale mass production, it may eventually replace most of the present "air-breathing" assemblies. There is a possibility that the technique may be expanded to large electrical units as well.

Up to the present time, sealed instruments have had one major drawback—the lack of a zero adjustment. Some companies are now introducing such a mechanism based on a bellows principle. Other instrument firms have developed different types of zero adjusters which should be on the market soon.

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FIBERGLAS-REINFORCED PLASTIC PARTS REDUCE TOOLING COSTS . . .

(*Continued from page* 517)

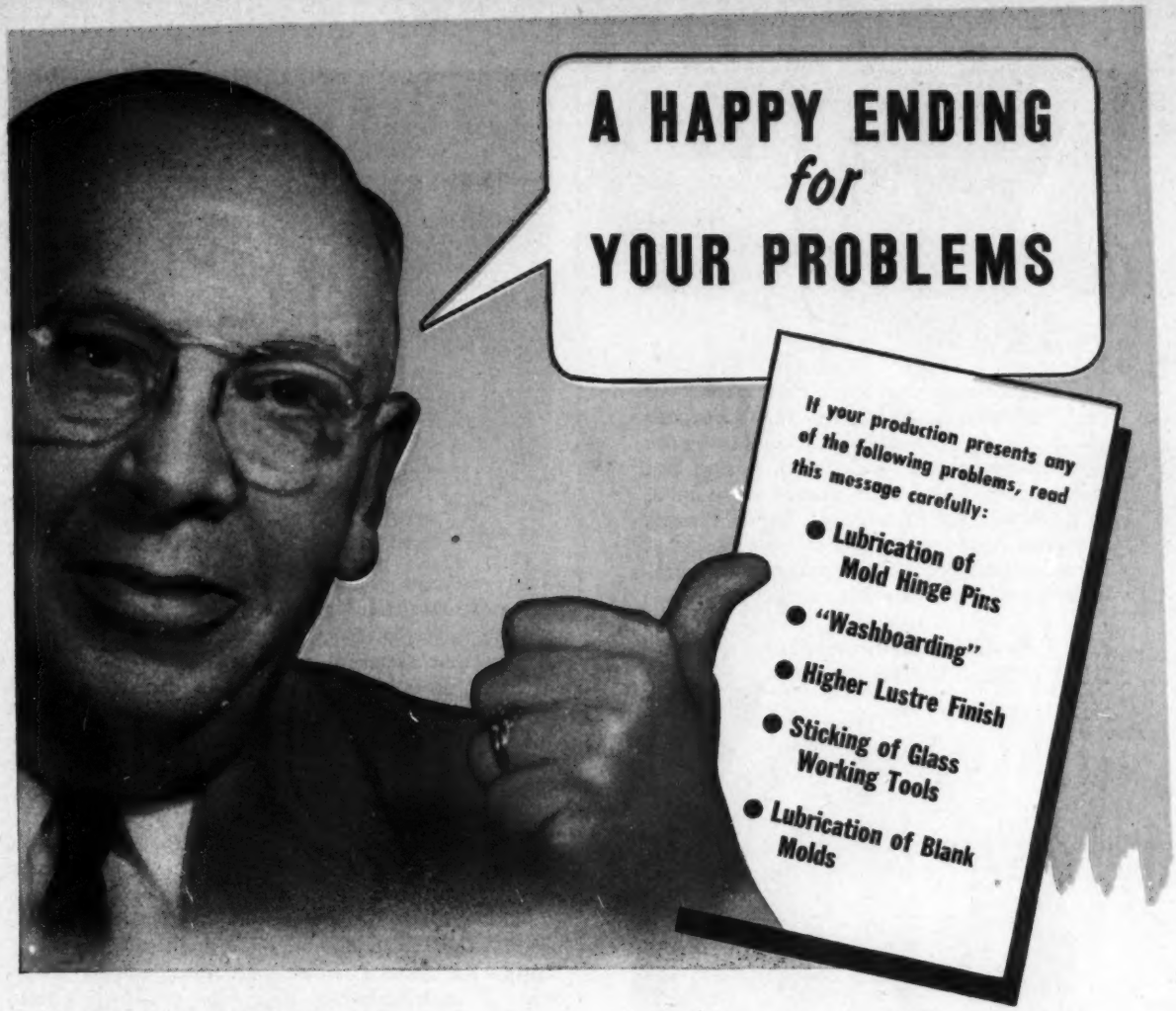
atmospheric pressure is sufficient to force the plies of the laminate into close contact with each other. The entire assembly is then rolled into an oven where the laminate is cured under temperatures ranging, in most cases, from 180 to 250 degrees, Fahrenheit.

Reduction in tooling costs is only one of several advantages inherent in the use of Fiberglas-reinforced plastics for complex parts. On the basis of the strength-weight ratio, the important mechanical properties of Fiberglas-plastic laminates are equal or superior to those of metal alloys commonly used. Ease of positioning of inserts or pre-formed shapes permits completely molded assemblies, cutting production time. Experience has demonstrated that production time is also saved because the material is not easily dented or deformed during installation.

NEW COMPANY FORMED FOR TECHNICAL EQUIPMENT

Frank C. Baker, Jr., formerly Service and Sales Manager of the Scientific Glass Apparatus Company, has recently formed a new company in the field of technical laboratory equipment.

The company will be known as the Baker Instrument Company and is located in Orange, New Jersey.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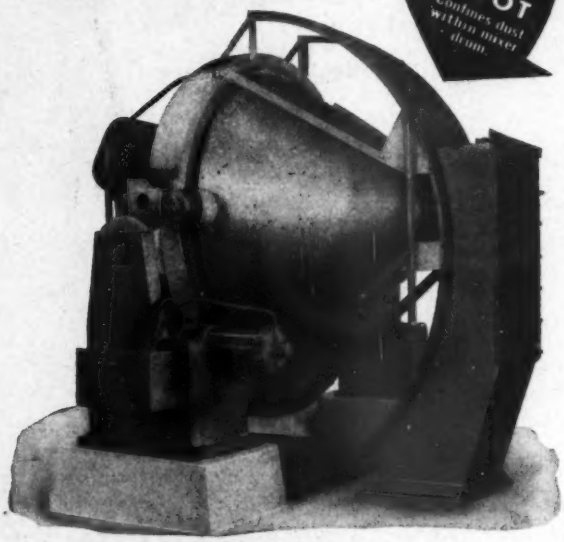
Confines dust within mixer drum.



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REPORT ON PITTSBURGH SECTION FALL MEETING

The Pittsburgh Section of the American Ceramic Society held its Fall Meeting on October 12 at Mellon Institute. The meeting was reported to be the largest and most successful in the history of the Section.

At the Joint Session, Dwight G. Bennett, Research Professor, Department of Ceramic Engineering, University of Illinois, spoke on "Some Special Wartime Investigations of Ceramics." The paper described the work leading to the development of enamel-type metal protective coatings featuring low infra red emissivity at high temperatures and the development of ceramic bodies capable of satisfactory resistance to temperature of changes of as much as 2000° in 30 seconds.

The Glass Division then met and the papers presented were: "The Effect of Iron on Fluorescence in Glass" by L. Thorington, R. Russell, Jr. and Alexander Silverman; "The Resistance of Plate Glass to Alkaline Solutions" by A. Junge and M. S. Tarnopol; "Thermal Emissivity of Glass and Plastics" by H. Noble; "Annealing Strains in Glass and Their Degree of Permanence. Measurements of Optical Retardation Over a Seven-Year Period in Glass Container Manufacturers' Standardized Discs" by L. G. Ghering and T. D. Green; and "Tracing the Flow in Glass Tank Furnaces" by F. L. Bishop, Jr. A sound movie feature entitled, "Glass Manufacture in England and Sheffield School of Glass Technology," was presented by the courtesy of Dr. J. C. Hostetter of Mississippi Glass Company.

Officers and committee men of the Whiteware Division and the Editorial Standards Committee of the National Society met on Saturday, the 13th. A dinner and dance held at the University Club completed the scheduled program.

Pictured above are the Pittsburgh Section officers and committee chairmen. Reading left to right: Norbert Garbisch, Chairman, Entertainment Committee; A. Paul Thompson, Chairman, Dinner Committee; H. E. Simpson, Section Chairman; J. W. Jordan, Section Vice-Chairman; L. A. Smith, Treasurer; J. S. Nordyke, Chairman, Publicity Committee and H. M. Parkhurst, Secretary.

• Forter-Teichmann has announced its removal to new and larger quarters. The new offices are located at 610 Smithfield Street, Pittsburgh, Pa.

BATCH HOUSE ASSIGNABLE CAUSES IN DENSITY CONTROL . . .

(*Continued from page* 513)

size can be controlled within fairly satisfactory limits. Trouble can occur, however, when the source of supply is changed and due regard is not given to this question of grain size. While this is an assignable cause of minor importance, it may at times enter the picture and must be considered.

The problem of tracking down assignable causes in the density control charts can be rather difficult in those plants using large amounts of foreign cullet. When one uses cullet of his own manufacture (and hence of known composition), it can often be introduced into the batch without regard to its grain size and in many cases it does not have to be mixed with the batch. In these cases there is often no adverse influence on the chemical composition of the glass being produced. With foreign cullet, which is invariably somewhat different in chemical composition from the glass which would be produced from the raw materials alone, it is not possible to just crush the cullet to any convenient size, mix it with the batch material in variable amounts or to just shove it in the doghouse. If it is desired to keep the glass composition (density) within the control limits, it is absolutely necessary to crush the foreign cullet to a comparatively small size to intimately mix it with the other batch materials to maintain a definite proportion of foreign cullet to batch and to correct the batch for the differences in chemical composition between the foreign cullet and the glass that is to be produced.

The care taken to insure correctly mixed and proportioned batch, which in turn minimizes the assignable causes, can be quickly nullified if precautions are not taken to prevent the segregation or demixing of the batch during its transfer from the mixer to the doghouse. It is well known that the best advice that can be given in regard to the prevention of demixing is that excessive handling of the mixed batch should always be avoided. If the handling system is such that the mixed batch reaches the doghouse by a series of "drops" and "pick-ups," the chances are that demixing will take place at every transfer point. When segregation is suspected of being the assignable cause, it becomes necessary to check every point in the batch conveying system by chemical and physical methods in order to determine when and where it is taking place. Its elimination then becomes a matter of redesigning the method of batch transfer.

CORNING GLASS APPOINTS MEDICAL DIRECTOR

Dr. Lewis J. Graham has recently been appointed medical director of the Corning Glass Works to succeed Dr. Willis C. Templer who died last May.

Dr. Graham has been with the U. S. Navy. Prior to his entrance into the Navy, he was associated with Dr. Templer for a number of years. He attended Alfred University and received his medical degree at Rochester Medical School.

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REFRACTORIES OF THE FUTURE . . .

(*Continued from page* 516)

lives upon being handed a thoria brick of the same size weighing 27 lbs.

Hydration Difficulties

The first six chemical elements in Tables I and II belong in Group II of the Periodic Table. With the exception of beryllium and possibly zinc, their oxides present a major problem due to a tendency to hydrate in contact with moisture. For magnesium oxide a commercial solution was reached many years ago in the high temperature "dead burning" process. However, no amount of heating will bestow a similar degree of stability on the oxides of lime, strontium or barium. Brick made of any of these three oxides, heated to a normal firing temperature, will shortly afterwards be found to be a pile of dust. Thus for use as refractories this group has high melting point but not utility. The nearest approach to a solution of this problem is the one which has been applied to the moisture-stabilization of dolomite. This carbonate mineral ($MgCO_3.CaCO_3$) yields, on heating, a mixture of the oxides of magnesium and lime. Their stabilization, which was for years a major research problem, was eventually accomplished by converting the calcium oxide to highly refractory calcium silicates which also are resistant to hydration. A similar solution is applicable to lime alone (without magnesia) but the chemical nature of the resulting product is drastically altered.

The refractory metal oxides of chromium, cobalt and nickel are believed to be easily reducible to metal although they would be usable under oxidizing conditions. The research worker will look long and hard for literature references to any prior studies of these oxides as refractories, although in the form of a chrome spinel, chromium comprises the familiar and widely used chrome brick.

The Mainstays

When various refractory materials are dismissed because of known stability limitations or for overwhelming economic considerations, there are not many left. While certain other possibilities are not excluded, full consideration of these factors leads to the conclusion that the most promising refractory materials for research on the problem outlined are magnesia (m.p. 2800°C, 5070°F) alumina (2050°C, 3720°F), and zirconium silicate or zircon (2430°C, 4410°F). Except for compounds of these three elements (and of carbon) there are no other stable refractory substances which would have a raw material cost under $3.00 per brick, and a melting point above 2000°C. Each is available in a high degree of purity. If in addition to the requirements already stated, one superimposes the specification that the composition must be one which is chemically resistant to important industrial slags, zircon cannot be considered to be in the same class with alumina and magnesia which have far wider utility.

Alumina and magnesia, already extensively used as refractories, are destined to become even more important. Production facilities for both have been increased during the war and progress has been made in the technology of composition control.

These are two of the materials from which refractories will be made in large tonnages for postwar industry and for industries which have not yet been conceived. The knowledge that high temperature processes are inescapable in a modern industry and that the refractories industry is ready with the necessary raw materials, forms the basis for an optmistic view of the future. It was because of this optimism that the refractories industry paid for its own wartime expansion, without government aid, and is now planning a major program of plant replacement and modernization.

OHIO STATE ADDS GLASS TECHNOLOGY STUDY

Ohio State University has recently appointed Dr. Henry H. Blau to the position of Professor of glass technology in preparation for the addition to its curriculum of a course in glass technology and engineering.

University officials feel that the rapid expansion of the glass industry and the expectation of even greater attainments in the field have indicated a need for such a program.

Dr. Blau is particularly suited to his new position in that he has been very active in research work pertaining to the glass industry. He has been associated with the Federal Glass Company for the past four years, prior to which he served with Macbeth-Evans Glass Company and then with Corning Glass Works. Dr. Blau is now dividing his time between Federal Glass Company and the University.

AGA ELECTS NEW INDUSTRIAL OFFICERS

The election of Henry A. Sutton and Karl Emmerling to the offices of Chairman and Vice Chairman, respectively, was the result of the 27th Annual Meeting of the American Gas Association held on October 24 and 25.

Mr. Sutton is associated with the Public Service Electric & Gas Company of Newark, New Jersey, and Mr. Emmerling is with the East Ohio Gas Company of Cleveland.

NATIONAL PATENT COUNCIL FORMED

The recently organized National Patent Council, a new organization of smaller manufacturers launching a nation-wide program in defense of the U. S. Patent System, has announced the appointment of John C. Patterson as executive vice-president. Mr. Patterson has been director of the patents and industrial research department of the National Association of Manufacturers since 1939.

The new organization has its headquarters at Gary, Indiana, and it is expected that offices will be opened soon in New York and on the Pacific Coast. Control of the Council is by a Board of Governors chosen by Regional Directors elected by smaller manufacturers representing many industries.

● C. O. Dawson, assistant treasurer and controller of the Owens-Illinois Glass Corporation, has been named a director of the Toledo Control of the Controllers Institute of America.

DEPARTMENT OF COMMERCE SURVEY COVERS GLASS MARKET IN MEXICO

Mexico consumes about $9,000,000 worth of glass and glass products a year and although that country's domestic glass industry has grown considerably, imports of about $3,000,000 worth of glass products are effected annually, offering a worth-while market for American manufacturers, according to a new issue of the Industrial Reference Service released recently by the Department of Commerce.

A special report on the Glass and Glassware Market of Mexico, prepared by Donald S. Parris, Acting Chief, Specialties Unit, Bureau of Foreign and Domestic Commerce, shows that there are now 15 factories in Mexico manufacturing glass products in addition to numerous small plants which were established during the war.

However, the Mexican plants do not manufacture appreciable quantities of plate glass, laminated safety glass, fancy cosmetic and perfume bottles, fibrous glass products, lighting-fixture glass, heat resistant ovenware, cut glass, and finer grades of tableware, tumblers and stemware.

Before the war certain Asiatic and European glass products were preferred by the Mexican consumer to those of the United States, the report said, indicating that United States manufacturers will have to make a concentrated drive if they want to capture an appropriate share of the Mexican market.

The report further states that German, Belgian and Czechoslovakian perfume bottles and fancy luxury items were favored because of their price, quality and finish; Belgian window glass was preferred because of its quality and low price; English window glass, although higher in price than American, was thought to be superior in quality; German and Italian scientific glass was thought to surpass United States glass in quality as well as being less expensive; French and Belgian cut glass was highly esteemed because of its excellent quality and low price; and Japanese novelty glassware was preferred because of its low price.

In addition to importing finished glass products, Mexico also imports from the United States such raw products used in glass manufacture as silica sand, soda ash, borax, sodium nitrate, selenium and cobalt, as well as various glass-making machines used in its plants.

The Mexican glass industry has a small export field of its own sending novelty glassware made of bubble glass to the United States and window glass, cheap glassware and bottles to Central America.

The report, which is a complete survey of the glass and glassware market of Mexico, is the first issue of Part 8 of the Industrial Reference Service and covers general products not discussed in the remaining parts of the service as issued by the Bureau of Foreign and Domestic Commerce.

The issues in Part 8 are made available occasionally and may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at an annual subscription price of $1.50. Single copies are 5 cents each.

• Owens-Illinois Glass Company announced that Dr. Charles R. Stumbo has joined the Process and Product Research Division.

J. Stanley Heuisler Philip I. Heuisler

MARYLAND GLASS ELECTS OFFICERS

In a recent announcement from Maryland Glass Corporation, it was made known that J. Stanley Heuisler has been elected president of the organization and chairman of the executive committee. At the same time, the appointment of Philip I. Heuisler, Jr. as executive vice-president was announced.

The newly-elected president has been a member of the firm for more than 20 years and, until recently, had been executive vice-president.

Similarly, Philip Heuisler has been with the firm for 15 years and will continue his position as sales manager in addition to his new duties as executive vice-president.

A.C.S. SECTIONS CHANGE MEETING DATES

The Western New York Branch and the New York State Ceramic Association, both sections of the American Ceramic Society, have announced a change in dates for coming meetings.

The Western New York Branch meeting is now set for the evening of November 16, and the New York State Ceramic Association is scheduled for a full day's meeting on November 17.

L-O-F EXPANDS RESEARCH ACTIVITIES

In a plan to intensify and enlarge its research facilities, Libbey-Owens-Ford Glass Company has started the construction of an addition to its technical building in Toledo.

It is the company's intention to carry on considerable research in the fields of specialized transparent glasses for present and future uses, plastics and plasticizers connected with the manufacture of laminated safety glass, new glass products and new and special coatings for mirrors, television and allied fields.

FOSTORIA GLASS ELECTS OFFICERS

The Fostoria Glass Company, at a recent Board of Directors' meeting, elected the following officers: C. B. Roe, Chairman of the Board and Treasurer; W. F. Dalzell, President; A. W. Koenemund, Vice President and Secretary; Merlin DuBois, Vice President in charge of Sales; and R. F. Hannum, Vice President in charge of Production.

INVENTIONS AND INVENTORS . . .

(*Continued from page* 520)

bottle to the proper level. A glass section 45 is provided in the syphon so that it is easy to observe when the flow has stopped and the water is at the proper height. A pointer 38 and a scale 37 are provided to facilitate the proper setting of the filling mechanism.

This patent, No. 2,383,947, is a joint invention of Messrs. Wensel, Wisner and Rugh, of Clarion, Pa., who assigned it to the Owens-Illinois Glass Company.

This invention employs the usual screen and the novelty appears to be that decorations are applied to both sides of flat bottles at the same time while the bottles are in an upright position, and the decoration is applied both by the upward and downward strokes of the squeegees. Fig. 8 is a vertical section of the machine showing a bottle in place upon a support 53 where it is centered by a chuck 54 which enters the mouth of the bottle. A pair of screens 16 are carried by frames 15. These frames are mounted upon vertical pivots and arranged to be moved to and from the bottle by a pneumatic cylinder. Squeegees 38 are mounted to slide vertically against the screens. In the figure they are shown at the lower end of their stroke in pans 52 which carry the coloring material. When the squeejees are lifted by air cylinders 50, decoration is applied to both sides of the bottle. At the top of the stroke the squeegees are moved away from the screen by stationary cams 49, which permits the coloring material, carried in advance of the squeegees, to run down the screen so as to be picked up by the squeegee on its down stroke. A pedal which has held the machine in operative condition is released, the screens swing apart, the centering chuck 54 is lifted, and the bottle is removed. Another bottle is placed in position and the pedal is again depressed which repeats the operation, applying the decoration to both sides of the bottle on the down stroke of the squeegee. After placing the bottle in position, the operation of the machine is entirely automatic.

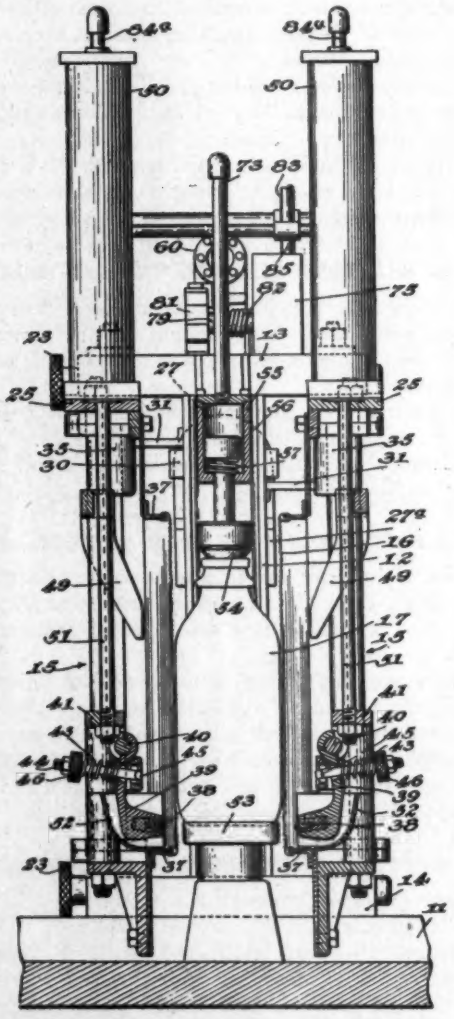

Fig. 8. Wensel, Wisner and Rugh, 2,383,947: Bottle decorating machine.

Two patents have been assigned to Libbey-Owens-Ford Glass Company, relating to the cleaning of glass preparatory to receiving a permanent coating such, for example, as silvering for a mirror.

Patent No. 2,383,-469, Colbert and Weinrich inventors, is based on the method of cleaning glass including the steps of a first cleaning of the glass by mechanical means, then applying a protective covering, then removing most of the protective covering to leave only a very thin film. The glass thus protected is placed in a vacuum chamber where the protective film is removed by evaporation. Immediately thereafter, the desired final coating is applied by thermal evaporation.

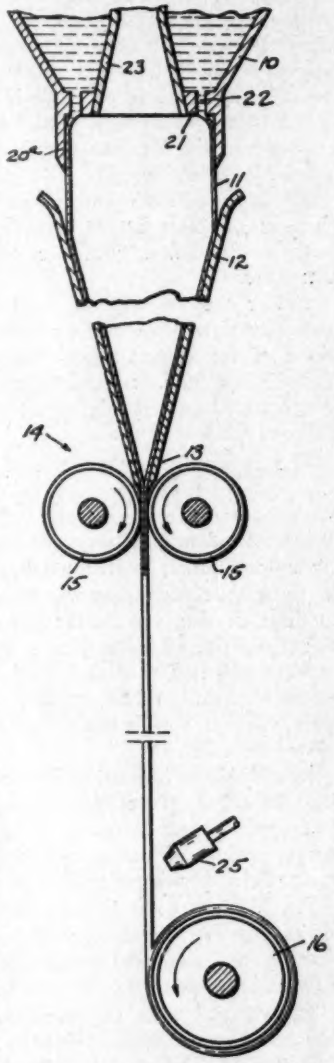

Fig. 9. Slayter and Snow, 2,-386,511; Apparatus for making glass film.

Patent No. 2,383,470, an invention by Willard L. Morgan, proposes to accomplish the same object as the foregoing patent by a somewhat different means.

Sprague Electric Company, of North Adams, Mass., is the owner of patent No. 2,386,628, invented by Matthew Nazzewski. This patent proposes to seal a metal cap, such as Monel metal, onto a boro-silicate glass, such as "Electrical Pyrex," by the use of an indeterminate

(*Continued on page* 537)

GLASS PACKAGES . . .
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Colorful **glass containers for an increasing variety of items will be in demand after the war. Superior use of color and design in decorations, labeling and legend will be the keynote to greater sales.**

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Dr. D. K. Coles of the Westinghouse Research Laboratories adjusts a special holder in a specially designed version of an infrared spectroscope which he has developed. A beam of infrared light passed through the sample reveals the chemical composition of the material with extreme accuracy.

BOOK REVIEWS

Ball and Roller Bearing Engineering

By Dr. Arvid Palmgren

A recent translation by Gunnar Palmgren and Bryce Ruley presents a comprehensive discussion of the design and characteristics of anti-friction bearings, as well as their application to mechanical equipment.

Dr. Palmgren, the author, has specialized in research and engineering of ball and roller bearings for almost 30 years and is a recognized authority in this field.

The book, a 270-page bound volume containing some 900 drawings and tables, carries detailed engineering data under chapter headings such as Common Bearing Types, Forces and Motions in Bearing, The Carrying Capacity of Ball and Roller Bearings, Bearing Selection, Design of Bearing Applications and Lubrication and Maintenance.

Published by SKF Industries, Inc., Front Street and Erie Avenue, Pittsburgh 34, Pa.

Chemical Engineering Catalog—1945-46

The 30th Annual edition of the Chemical Engineering Catalog, recently published, carries on the service started in 1915 to present vital information on equipment, supplies and raw materials.

The book provides a collected source of condensed and standardized data about equipment, machinery, raw materials, heavy and fine chemicals, and laboratory supplies used in the industries employing chemical processes of manufacture.

A trade name index, technical and scientific books section and chapters covering equipment and supplies and chemicals and materials are contained, all presented for easy reference.

Published by the Reinhold Publishing Corporation, 330 West 42nd Street, New York 18, New York.

• Henry B. Ramsay has been appointed manager of the Toledo branch of the Pittsburgh Plate Glass Company, effective November 1.

WINDOW GLASS MANUFACTURERS CONFER WITH OPA OFFICIALS

A special committee of window glass manufacturers recently met with OPA officials in an effort to obtain price rises to compensate manufacturers for changes in labor and other costs.

The meeting was called at the request of the American Window Glass Company of Clarksburg, West Virginia, in which, among other things, the company pointed out to OPA that the present differential between single-strength and double-strength glass was no longer justified by differences in cost of manufacture. To correct conditions, the company asked a general rise in single-strength glass.

Those present from industry were K. S. Wilson, P. J. Winschel and A. S. Crandon from the American Window Glass Company; W. M. B. Sine and Russell Rice of the Fourco E. Glass Company; and Richard B. Tucker and Joseph T. Owens of the Pittsburgh Plate Glass Company.

AMERICAN OPTICAL COMPANY SPONSORS EYE RESEARCH

Under the sponsorship of the American Optical Company, Dr. Ernst Wolf, of the Harvard Biological Laboratories, has been conducting considerable eye research in relation to the effect of ultraviolet light upon the eye.

Using baby chicks for experimental purposes because their visual characteristics approximate closely those of the human, Dr. Wolf has discovered that ultraviolet light definitely impaired the functioning of the chicks' visual mechanism even though under some conditions no obvious pathological changes in the eyes could be observed.

From his experiments, Dr. Wolf concludes that protective lenses, excluding the dangerous rays, be worn by all persons exposed to the radiations.

NATIONAL APPRENTICESHIP STANDARDS FOR STAINED GLASS INDUSTRY

The stained glass industry has adopted national standards of apprentice training in order to perpetuate the skills and techniques required by it and build up an adequate force of artisans in this country.

The National Joint Apprenticeship Committee has formulated these standards of training and has made available a booklet entitled, "Standards and Organization for Apprenticeship in the Stained Glass Industry," which gives detailed information of the procedure to be used during each step of the training.

The booklet may be obtained by writing to Apprentice-Training Service, War Manpower Commission, Washington 25, D. C.

L-O-F NAMES EASTERN SALES MANAGER

The Libbey-Owens-Ford Glass Company has made the announcement of the appointment of Harry J. Benson as sales promotion manager for the Eastern region.

Mr. Benson will have his headquarters in New York and will cover all the New England states, south to northeastern Virginia and into eastern Pennsylvania. He joined L-O-F in 1933 and, previous to his new assignment, was manager of industrial sales at the Cleveland office.

INVENTIONS AND INVENTORS . . .

(*Continued from page* 534)

layer of metal alloy consisting of about 97.5 per cent lead and 2.5 per cent silver. It is said that this provides a seal which will be tight and will not cause breakage

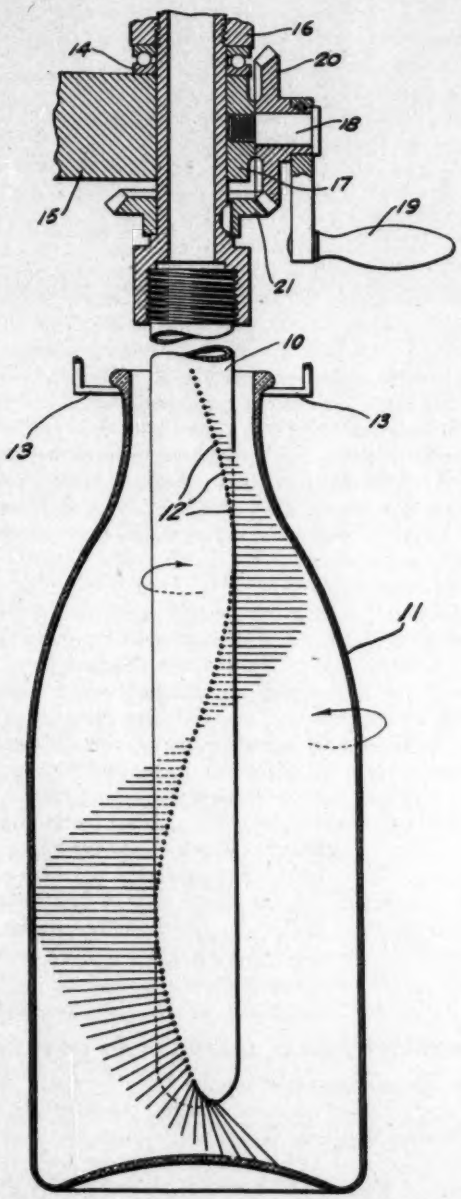

Fig. 10. Green, 2,386,455: Tempering nozzle for bottles.

of the glass due to difference in expansion.

Patent No. 2,386,511 shows an apparatus for making glass film and has been assigned to Owens-Corning Fiberglas Corporation by Games Slayter and Henry Snow. The object of the invention is to make glass sheets having a thickness of from .0001 to .0005 inches. This very thin glass can be used to replace mica, in which case it has the advantage of coming in sheets of practically any size, whereas mica comes in compara-

(*Continued on page* 538)

A NEW MODEL
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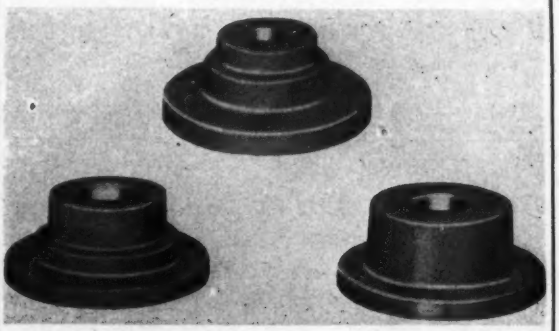

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Stauffer CHEMICAL SINCE 1885

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424 Ohio Bldg., Akron 8, O. — Orlando, Fla. — North Portland, Oregon — Houston 2, Texas

INVENTIONS AND INVENTORS . . .

(*Continued from page* 537)

tively small flakes. As shown in Fig. 9, the molten glass flows downwardly through a bushing 10 having a bottom plate 21 provided with a series of holes 22. These holes may be arranged in a circle or they may have an elongated form. The temperature of the issuing glass is such that the streams unite on the wall 20a to form a tubular glass stream 11.

This stream 11 is received in the upper end of a tube 12 which flattens the glass tube. The tube is held from collapsing by air pressure admitted through a conduit 23. Immediately below the tube 12 is a pair of rapidly rotating rolls 15 which flatten the glass still further and draw it rapidly downward. The issuing sheet of glass may be lubricated by oil or the like, applied by a spray 25. The thin glass sheet is then wound on a spool 16.

Harrison P. Hood has assigned patent No. 2,386,685 to Corning Glass Works. In order to eliminate the use of fining agents such as arsenic to remove gas from the glass, he proposes to remove the gas forming materials from the batch such as carbon dioxide and water vapor, before the glass is melted. This method is carried out by slowly heating the batch to a temperature around 600 to 800 degrees C, while the batch is heated, passing air through and over the batch, this air being free from carbon dioxide and water vapor, which removes the gas forming materials from the batch. The batch is then melted in the usual way.

A tempering nozzle for treating the inside of bottles is shown in patent No. 2,386,455, invented by T. D. Green, and assigned to Hartford-Empire Company. This nozzle is for discharging air carrying water. When a mixture of air and water is applied to the interior of a bottle, there is a tendency for the water to accumulate in drops on the inside of the bottle and thus prevent satisfactory tempering. This invention overcomes that difficulty by providing a nozzle 10, shown in Fig. 10, with a series of jet holes 12 which extend spirally around the nozzle. The nozzle is rotated in the direction of the arrow and, if desired, the bottle may be rotated in the opposite direction so that the discharged jets of air have a screw-like action, blowing any drops which may accumulate in the bottle upward and out the neck.

ORGANIZATIONAL CHANGES AT CORNING

Recent announcements from the Corning Glass Works have made known various changes affecting the Bulb and Tubing Division, Technical Products Division and the plant's mixing and melting department.

Marshall Dana and Thomas S. Wood Jr. have been appointed manufacturing manager and sales manager, respectively, of the Bulb and Tubing Division. Electronic Products Sales, under the managership of C. J. Phillips, has been transferred to the Technical Products Division.

John L. Hanigan, of the Fall Brook Plant, has been appointed assistant to the manufacturing manager of the Technical Products Division to be succeeded by Paul T. Clark, formerly plant production superintendent. Thomas J. Hoven becomes the new production superintendent at Fall Brook and George W. Coveney becomes foreman of the plant's mixing and melting department.

A. H. HEISEY RECEIVES AWARD

The A. H. Heisey Company was recently awarded a certificate of public service from the Brand Names Research Foundation.

Manufacturers of glassware since 1895, the company was the first to be honored in a series of luncheons and dinners throughout the country for American businesses that have sold their brand name products for 50 years or more.

H. C. Mueller, right, received the certificate for the company. Henry E. Abt, left, managing director of the Brand Names Research Foundation, made the award.

L-O-F MAPS PLAN IN VETERAN REHIRING

The Libbey-Owens-Ford Glass Company, which has already rehired 118 former employees released from the armed forces, has mapped out a campaign to offer approximately 2,000 jobs to former employees being released from the services.

Under the L-O-F plan, plant managers are notified of the date for a former employee's discharge. If the discharged serviceman does not contact the company within 30 to 45 days, the plant personnel director calls on him at his home to let him know that his old job is available. He is not obligated to return to his old job and is given the opportunity to qualify for a better job if his war experience or training makes him eligible for a more skilled or different type of glass-making.

NEW ASSISTANT MANAGER OF MARKET RESEARCH AT PENN SALT

Pennsylvania Salt Manufacturing Company has appointed George T. Collins as assistant manager of market research, according to a recent announcement.

Mr. Collins, formerly associated with the Barrett Division of Allied Chemical & Dye Corporation and a member of various chemical societies, will assist R. L. Davies in supervising the activities of the market research department.

• The Owens-Illinois Glass Company has opened a new sales office on the west coast, according to a recent announcement. The new office is located in the Pacific National Building in Los Angeles, California.

Snowflake . . .

is the answer to securing beautiful distinctive satin finish designs on glassware. The finish is smooth, uniform, attractive and has a pleasing satin feel. It will not collect dirt and is a permanent finish.

The application of Snowflake for decorating is very simple and requires no special equipment. Depending upon the glass, Snowflake will give a beautiful satin finish in ½ to 2 minutes. The design possibilities are unlimited and many beautiful effects are possible that can be profitably added to production line glassware to increase their sales appeal.

Snowflake is being successfully used to satin-etch gin bottles, tumblers, vases, bowls, dials, gift packages, vials, architectural glass, window and plate glass, fluorescent fixtures and lighting bowls.

Snowflake is available for immediate shipment in quart, 1 gallon and 5 gallon containers.

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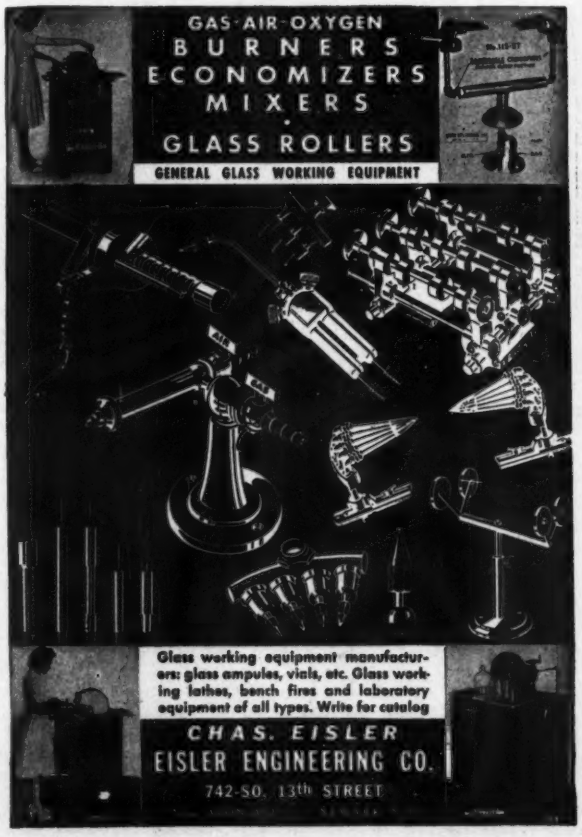
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Manufacturers' Agent with United States references offers complete Sales Representation for Colombia and Panama Republics, on commission basis, to manufacturers of table glassware in general, all kinds of bottles and glass containers, window glass, furniture mirrors, glass building blocks and the general line of glass and glassware. Air mail address: LUIS FERNANDO PRADA, Carrera 52 No. 70-220, Barranquilla, Colombia Republic, South America.

WANTED—Engineer or Draftsman, familiar with glass furnaces, lehrs, machinery, etc. Permanent position. Arthur W. Schmid, 1214 Investment Building, Pittsburgh 22, Pa.

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FACTORY REPRESENTATIVES and DISTRIBUTORS with branches in all principal cities in the Union of South Africa desire sole agencies for manufacturers. Also, prepared to buy stocks. Samples would be appreciated with your reply to avoid unnecessary delay. References: Barklays Bank, Chiswell St., London, and Union Shippers Co., Chiswell St., London. Address Norman Shapiro & Co., Box 6916, Johannesburg, S. Africa.

WANTED—General Plant Construction Engineer who can plan and supervise building construction, compressor and compressed air piping installations, blower and wind piping installations and general plant layout work. Man should have working knowledge of structural steel design and should be familiar with the relation of above work to glass container plant operation. Give age and detail of past experience in first letter. Reply Box 30, c/o The Glass Industry, 55 West 42nd Street, New York 18, N. Y.

WANTED POSITION—Ceramic engineer desires to change location to Pennsylvania or near vicinity. Three years experience in laboratory work, quality control and glass manufacture. Will accept position in ceramic or allied industry. Reply Box 31, c/o The Glass Industry, 55 West 42nd Street, New York 18, New York.

WANTED—Position as mold design supervisor or factory technician. Twelve years' designing experience. Familiar all types bottle machines. Married, age 35, references. Reply Box 29, c/o The Glass Industry, 55 West 42nd Street, New York 18, N. Y.

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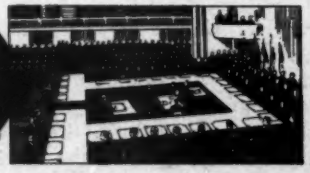
1907 was a great year . . . and 1921 was marked by international accord



The International Disarmament Conference convened in Washington, D. C., to discuss cessation of naval construction . . . United States, Great Britain, France and Japan signed a Pacific Treaty . . . Andrew W. Mellon of Pennsylvania was appointed Secretary of the Treasury . . . Bert Acosta broke the American speed record for airplanes . . . American War Relief agencies were feeding millions of Russian adults and children daily.

Architects and builders, industry and agriculture were in accord also that Banner Lime, now in its fourteenth year, was unmatched for purity and uniformity. National Mortar & Supply Company, Grant Bldg., Pittsburgh, Pa., Established 1907.

In 4 essential industries—agriculture, building, glass and steel . . . lime and limestone are essential.